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C O H E N

ON

I N H A L A T I O N.

COHEN ON CROUP.

Croup, in its Relations to Tracheotomy. Based on a careful study of the published records of more than five thousand cases of Tracheotomy in Croup, performed in various portions of the world. By J. SOLIS COHEN, M.D., Lecturer on Laryngoscopy and Diseases of the Throat and Chest in Jefferson Medical College. Reprinted from the "Transactions of the Medical Society of Pennsylvania." Octavo. Price, \$1.00.

"Would that more such books were published," was our sincere wish on finishing the attentive perusal, we may say study, of the work, the title of which heads this article. It is a book of only seventy-eight pages, and what most people call not an original book; yet, in our deliberate judgment, the whole medical profession owe DR. COHEN a debt of gratitude for it which can only be paid by each member doing his part toward making it known to every other member. It contains a conscientious compilation and judicious appreciation of all that could be gathered by the author upon the subject of which it treats; and, so far as knowledge of a practical subject can be acquired by reading, whoever chooses to make these comparatively few pages his own will become *thoroughly posted*."—*New York Medical Record*.

"Viewed as a whole this *brochure* contains much that every practical surgeon should know, and gives a full exhibition of the present position of this remedial measure, and its author is entitled to the thanks of the profession for the good work he has done."—*The American Journal of Medical Sciences*, April, 1875.

OTHER ESSAYS BY DR. COHEN.

A Brief Exposition of the Management of the Laryngoscope. Illustrated; 8vo., pp. 19. 1871.

Fetid Coryza. 12mo.; pp. 16. Philadelphia, 1874.

Sore Throat. 8vo.; pp. 11. Philadelphia, 1874.

INHALATION
IN THE TREATMENT OF DISEASE:
ITS THERAPEUTICS AND PRACTICE.

A TREATISE

ON THE

INHALATION OF GASES, VAPORS, FUMES, COMPRESSED AND
RAREFIED AIR, NEBULIZED FLUIDS, AND POWDERS.

BY

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OF PHILADELPHIA, ETC., ETC.

SECOND EDITION, REVISED AND ENLARGED, WITH
MANY NEW ILLUSTRATIONS.

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PREFACE TO THE SECOND EDITION.

THE author's treatise on Inhalation having been some time out of print, and a new edition called for, the text has been subjected to revision, and such additions and alterations have been made as seemed requisite to present the subject from the standpoint of the day. It has not been deemed advisable to add to the number of cases recorded in the first edition, as this would have incumbered the volume without serving any adequate purpose; indeed, a number of cases, previously recorded, are omitted in the present edition as superfluous.

The article on Compressed and Rarefied Air has been much enlarged, to render it commensurate with the amount of attention bestowed on pneumatic therapeutics, abroad, in the treatment of certain affections of the lungs and heart.

Additional illustrations have been introduced where they have been thought likely to add to the value of the work. For several of these we are gratefully indebted to Codman & Shurtleff, of Boston, Tiemann & Co. and J. Reynders & Co., of New York, and Gemrig, of Philadelphia.

1431 WALNUT STREET,
PHILADELPHIA, January, 1876.

PREFACE TO THE FIRST EDITION.

INHALATION, especially by the method of nebulization, is at present attracting favorable attention from the profession.

At the annual meeting of the Ameriean Medical Assoeiation, held in Baltimore, in 1866, a committee, of which the writer was ehairman, was appointed to prepare for the meeting of 1867 a report on the Therapeutics of Inhalation. In the preparation of this report, the writer accumulated a quantity of material much too voluminous for that purpose, and determined to incorporate the most valuable portions in book-form, presenting in some detail the historieal record of experiments, pathologieal studies, etc., from which eonclusions were drawn for the report. The prineipal literature on the subject is foreign—for the most part German—the most elaborate work being (*Die Inhalations-Therapie*) by Dr. George Lewin, of Berlin, from which much has been drawn in the preparation of the present volume, besides which, as will be seen, many other authors have been consulted, as also an extensive file of foreign and Ameri-can journals; while the private experience of several praetitioners in this country has been laid under eontribution.

PHILADELPHIA, October 1st, 1867.

INTRODUCTION.

IN examining the literature upon our subject, we find that from the earliest ages inhalation has been employed in Greece, in Rome, in Arabia, and thence, with the extension of medical knowledge, everywhere. Again and again has the method been extensively resorted to, and subsequently fallen into disuse, perhaps into abuse, for at each resumption it has seemed necessary to advance specious reasons to account for its previous neglect.

From time to time fresh discoveries in pneumatics have given renewed impulse to further investigation of the subject; and at each period with some permanent beneficial result.

Thus the discovery of oxygen by Priestley and Scheele in the middle of the last century, led to experiments upon the economy with "different kinds of air;" and atmospheres noxious and innocuous became pressed into the service of therapeutics.

Then, early in the present century, the discovery of the peculiar properties of chlorine and iodine, led anew to examination of the physical properties of volatile substances; and the inhalations of resinous materials, of narcotics, etc., were again brought into medical requisition.

Again, the observed effects of compressed air in cer-

tain of the mechanical employments, attracted experiment as to its value as a therapeutic agent.

Finally, the more recent device of a method of subdividing a liquid into a spray-cloud or nebula, and thus utilizing it in this attenuated form to the purposes of inhalation, and enlarging at once its sphere of usefulness, gave a fresh impetus to the study of the Therapeutics of Inhalation, which has resulted in the acquisition of new and valuable methods for at least affording grateful relief in certain pulmonary affections, to the cure of which medicine is, unfortunately, inadequate.

The personal attention necessary to insure proper inhalation, even of the most volatile substances, has no doubt debarred many physicians from a resort to the method, in preference to the much easier plan of advising a patient to swallow a draught or a pill; and this, perhaps, is the reason why it has so long been found principally in use by a class of practitioners, "who," to use the language of the author of one of our best works on Therapeutics, "inhabit the debatable region between medicine and quackery." Dr. Rogers, in a note to Elliotson's Practice, Philadelphia Edition, 1844, p. 804, says: "A medical man, when he orders a patient to inhale vapors, must give his personal attention to the manner in which it is performed, if he wishes to have his intentions efficiently carried out. On one occasion, in a large hospital, when a patient with ulcerated sore throat had been ordered to inhale steam, I found him with a tin inhaler comfortably tucked under the bed-clothes with a cork stuffed into the air-tube. The consequence of this was that the patient was obliged to remove his mouth from the instrument after every inspiration, and after all his laborious efforts the supply of

steam was very inefficient. The nurse (in every respect an excellent one), on being questioned as to the use of the cork, very naturally replied that it was ‘to keep in the steam ;’ and added, that she had been in the hospital eleven years and never saw an inhaler used in any other way. There is nothing surprising in all this. Nurses are not expected to understand the principles of pneumatics. On instituting an inspection of the other inhalers in the hospital, every one of them was found duly provided with a cork.”

The material collected in the following pages will show that inhalation has at all times possessed the confidence of men in good professional repute. Our various works on Therapeutics and *Materia Medica*, Copland’s Dictionary, and the works on Practice issued in the earlier portion of the present century, give historical lists, more or less complete, of the various authorities who have at times employed inhalations and recommended them, as well as lists of the remedies resorted to. To have presented a complete list in the present volume would have occupied many pages that are devoted to matter more practical, and the writer has been unwilling to furnish an incomplete record. Instead of an extended display of authorities, therefore, reference is made in each appropriate place to those individuals to whom the profession is indebted for having first prominently placed before them the merits of the inhalations of various remedies in certain diseases ; and with regard to the new method of inhaling nebulized fluids, the authorities cited are, as far as possible, authenticated, and credit given to the sources from which information has been derived.

The subject is still incomplete ; the observations re-

corded at various times are not yet sufficiently numerous, accurate, or corroborative of each other for the deduction of positive conclusions; and it is to be regretted that the value of a faithful record of unfavorable results has not attracted a sufficient share of attention from those who have hitherto written on the subject.

Such observations and records of authors, abroad and at home, as have seemed to the writer most valuable from the mass of matter which has accumulated on his hands, are laid before the reader that he may form his own estimate of their value. The writer has endeavored to present the subject as impartially as a decided bias in favor of inhalations would permit.

It may not be amiss here to answer an objection that will often be heard urged against inhalation. It is this: Inhalation being defended on the ground that affected structures are thus subjected to local treatment; and, at the same time, it being impossible to limit the local action to the diseased structures; where, then, the great benefit? We see, however, that the objection holds good in a measure, with regard to medicines given by the stomach; they affect more or less the entire system, though their action may predominate in some one direction; but there is a class of therapeutists who teach that it is by sustaining those portions of organs still healthy, and protecting them against the extension of morbid processes, which have already imperilled the integrity of part of their substance, or at any rate temporarily impaired their natural functions, that we are able to extend the restorative influence by continuance of molecular action into the very structures diseased, and thus excite them, as far as they are not disorganized or changed, to a return of normal function. Healthy tis-

sues, too, resist the effect of medicines, local or general ; thus we can rarely restrict the action of a lotion or a caustic to the diseased structures, and the parts in immediate contiguity often receive a full benefit from the application ; still, they recover from it, so that even an accidental occurrence of the kind affords no valid argument against the use of such local treatment.

It seems plausible, too, that even when remedies act systemically, we should anticipate better results by impressing first the particular organs designed to be acted upon with any remedy by its passage through the system, than by impressing the system primarily and the affected organ secondarily, by the passage through it of medicated blood-plasma, or modified nerve-force ; besides which, the systemic exhalants are more actively called upon for their emunctorial duties than are the systemic absorbents for the impression of some special organ ; added to which, the changes which may occur during the progress of the digestion of a medicine may alter its primary effect ; and if any difference has been detected in the effect of any remedy as administered by inhalation or deglutition, it is not illogical to trace the cause, in a great measure, to the digestive process to which it is subjected in the stomach, where the remedies undergo preparation for absorption. We administer remedies for the production of effects known to occur after exposure to the digestive process, and it may be possible that their action would be different were they not thus digested ; at any rate, we act upon such premises, for we diminish the quantity of medicine to be introduced by direct absorption into the body for a certain effect, whether by the skin or by the bronchial mucous membrane ; and therefore, in resorting to inhalatory

therapeutics, we must carefully watch the effect of remedies; for much judgment may be required in the selection of a special *materia medica*. One advantage is, that remedies exhibited for inhalation are usually presented in a simply medicinal form, deprived in great measure of the original (resinous, woody, or other) connecting medium, which is more apt to be preserved as usually administered; and another is that the misfortunes and errors of the elaborate prescriptions of polypharmacists are less apt to be endured by the patient.

As has again and again been proven by actual experiment on the lower animals, and on man, the mucous membrane of the respiratory organs has a much greater capacity for absorption than that of the stomach, than which it is much more delicate; and for articles not desirable to be exposed to the solvent principle of the gastric juice, inhalation is at least as advantageous a mode, in many instances, for the administration of appropriate remedies, as the skin or connective tissue. The material inhaled comes directly in close juxtaposition to the blood while in its most vital state, and is thus more promptly and more thoroughly absorbed into the tide of the circulation than when it traverses part of the venous circuit before exposure to the inspiratory effort. It is often advantageous, too, that nothing shall interfere directly with the digestive functions.

The promptness with which the respiratory mucous membrane absorbs is well shown in the action of general anaesthetics, and he who is sceptical as regards the facility with which other articles of the *materia medica* are absorbed, can perform upon himself the experiment of taking a certain amount of a narcotic by the stomach, and at another time, under similar conditions of body as

well as may be, inhaling a similar amount of the same narcotic in solution, by some of the methods described in the pages of this volume; and, unless he be the subject of some idiosyncrasy, the truth of the matter may safely rest upon his own verdict as to the resulting sensations.



TABLE OF CONTENTS.

	PAGE
PREFACE TO THE SECOND EDITION,	v
PREFACE TO THE FIRST EDITION,	vi
INTRODUCTION,	vii
TABLE OF CONTENTS,	xv
LIST OF ILLUSTRATIONS,	xix

P A R T I.

THE INHALATION OF AIRS, GASES, VAPORS, AND FUMES,	13
Inhalers,	19
Atmospheric Air,	33
Condensed and Rarefied Air,	37
Oxygen,	61
Ozone,	79
Nitrous Oxide,	80
Nitrous Acid,	81
Hydrogen,	82
Sulphuretted Hydrogen,	83
Carbonic Acid,	83
Carburetted Hydrogen,	87
Chlorine,	91
Iodine,	96
Iodoform,	110
Bromine,	110
Sulphur,	111
Ammonium,	113
Chloride of Ammonium,	115
Chloroform,	118
Ether,	121
Nitrite of Amyl,	131
Balsamic Vapors,	133
Resinous Vapors of the Coniferae,	136

	PAGE
Tar,	139
Oil of Turpentine,	144
Oils of Pine,	148
Other Essential Oils,	150
Oxygenated Essences,	151
Creasote,	151
Carbolic Acid,	154
Opium and other Narcotics,	156
Nitrate of Potassium,	163
Camphor,	164
Lime,	166
Arsenic,	170
Mercury,	172
Chloride of Copper,	176
Hot Water,	177

P A R T I I.

INHALATION OF NEBULIZED FLUIDS, OR SPRAYS,	184
Nebulized Medicaments and the Apparatus for their Production,	184
Experiments upon Men and Animals as to the Penetration of Nebulized Fluids into the Respiratory Passages,	213
Experiments with Negative Results,	214
Experiments with Positive Results,	224
Report on the foregoing Experiments to the Parisian Academy of Medicine,	230
Further Experiments in Germany and elsewhere,	233
Pathological Proofs of Penetration,	239
The Inhalation of Nebulized Fluids,	246
The Proportion of Nebula Inhaled,	247
Immediate Effects of the Inhalation of Nebulized Fluids,	250
Manner of Conducting the Inhalation of Nebulized Fluids,	251
Number, Strength, and Duration of Inhalations, etc.,	257
Articles of the Materia Medica suitable for Nebulization,	259
Summary,	334

P A R T I II.

THE INHALATION OF POWDERS,	336
The Insufflation or Inhalation of Powders in Affections of the Respiratory Organs,	336

	PAGE
Experiments on Men and Animals proving the Penetration of Powders into the Respiratory Tracts,	345
Pathological Proofs of the Penetration of Powders into the Lung Tissue,	350
Articles of the Materia Medica employed by Inhalation or Insufflation in Powder,	363

P A R T I V.

MEDICATED ATMOSPHERES,	370
INDEX,	381



LIST OF ILLUSTRATIONS.

	<small>PAGE</small>
FIG. 1. Mudge's Inhaler (from Mudge),	20
2. Wolfe-Bottle Inhaler,	21
3. Simple modification of Wolfe-Bottle Inhaler,	21
4. Beigel's Mouth-Piece (from Beigel),	22
5. Mackenzie's Eclectic Inhaler (from Mackenzie),	24
6. Mandl's Inhaler or Fumigator (from Mandl),	26
7. Bumstead's Calomel Vaporizer (J. Reynders & Co.),	29
8. Pomeroy's Inhaler (Gemrig),	30
9. Lewin's Apparatus for the Inhalation of Nascent Vapors of Sal Ammoniac (from Lewin),	32
10. Dobell's Residual Air-Pump (G. Tiemann & Co.),	44
11. Waldenburg's Apparatus for Inhalation of Condensed and Rarefied Air (Gemrig),	45
12. Biedert's Apparatus for Inhalation of Condensed and Rarefied Air (J. Reynders & Co.),	49
13. Fränkel's Apparatus for Inhaling Condensed and Rare- fied Air (J. Reynders & Co.),	52
14. Stoerck's Apparatus for Inhalation of Condensed and Rarefied Air (from Stoerck),	56
15. Porter's Croup-Kettle (J. Reynders & Co.),	182
16. Salcs-Girons's Pulverisateur Portatif (from Lewin),	186
17. Mathieu's Néphogène (from Lewin),	189
18. Mathieu's Nebulizer (from Mathieu),	193
19. Lewin's Glass Nebulizer (from Lewin),	195
20. The Bergson Tubes,	197
21. Bergson's Apparatus with the Foot-Bellows (from Lewin),	198

FIG.		PAGE
22.	(Modification of) Clarke's Nebulizer (Codman & Shurtleff),	199
23.	Dr. Sass's Horizontal Nebulizer, with Tubular Reservoir (G. Tiemann & Co.),	202
24.	Bergson's Tubes reversed, with the Reservoir on top,	205
25.	Siegle's Steam Nebulizer,	208
26.	Codman & Shurtleff's Steam Nebulizer (Codman & Shurtleff),	209
27.	Modified Form of Siegle's Steam Nebulizer, with Duckbill Tubes,	210
28.	Rauchfuss's Insufflator (Codman & Shurtleff),	341
29.	Oro-nasal Respirator (Tiemann & Co.),	376

ON INHALATION.

PART I.

THE INHALATION OF AIRS, GASES, VAPORS, AND FUMES.

THE utilization of the normal act of inspiration for conveying air impregnated with remedial agents to the diseased structures themselves, in the treatment of disorders of the lungs and air-passages, has attracted the attention of physicians from the remotest period; and even in the writings of Hippocrates there is a record of an excellent apparatus for the purpose of administering inhalations.

Gases, vapors, and fumes may be inhaled diffused in the air of the apartment occupied by the patient, or they may be conveyed directly to the air-passages by means of some special contrivance. Inhalations of the former sort are more or less continuous, and of the latter sort more or less intermittent.

Inhalations of oxygen, nitrous oxide, carbonic acid, chlorine, and other gases, can be administered at ordinary temperatures; and so, also, the vapors from iodine, creasote, carbolic acid, camphor, ether, chloroform, nitrate of amyl, and nascent chloride of ammonium.

The vapors from the volatile ethereal oils, from water, and decoctions of aromatic, resinous, and narcotic plants, and the fumes from tar, sulphur, arsenic, and mercury, are evolved at a more or less elevated temperature; artificial heat being employed for the purpose. The material from which the vapor is to be evolved, if soluble, may be simply added to hot water, or be further heated by a lamp, as the case may be; and comparative uniformity of temperature during the inhalation may be secured by placing the vessel containing the evaporating substance in a sand or hot-water bath, or by keeping a flame beneath it. The air to be impregnated with the volatile substance may simply pass over the vapor as it is evolved, or may be forced through the warm water or medicinal solution, and become impregnated in its passage. The latter plan is that most frequently adopted.

The fumes of substances volatile by combustion are produced by throwing the substance upon heated metal, or simply upon burning coals, or by slow ignition in substance or in the form of pastilles, saturated paper, and the like; or the material may be packed in a pipe, or rolled into cigarettes, and smoked after the manner of tobacco.

The vapors of solid substances volatile at ordinary temperatures, as of iodine, camphor, and chloral, are usually inhaled from some sort of tube in the interior of which the substance is confined by light wads of cotton or wool, one end of the tube being placed in the mouth or nostril, and inspiration being made through it. Certain liquid substances of great volatility may be dropped upon cotton or sponge, and placed in a similar reservoir; or the saturated cotton or sponge may be placed in the bottom of a wide-mouthed bottle or jar; or the substance

itself may be simply poured upon the bottom of such a vessel.

Even those substances usually administered warm are sometimes administered at ordinary temperatures ; and some authors* have expressed a decided preference for cold, over hot inhalations, in chronic complaints.

When the patient is not kept more or less continuously in an artificially medicated atmosphere—a respiratory dietetic plan of treatment not often adopted at the present day—the inhalations are administered medicinally at appropriate intervals, and continued for a few minutes or for a longer period, according to the nature of the remedy, the character of the malady, and the specific object in view. Medicinal inhalations are usually administered to best advantage before eating ; because, as a rule, they are less apt to offend the empty than the full stomach ; while, moreover, if they are to be of service, they often stimulate the appetite, or at least promote the desire for food. After having taken an inhalation, the patient should be confined to his apartment, or at least to the house, for from fifteen to thirty minutes, especially if warm vapors have been inhaled ; as sudden exposure of the warmed-up respiratory tract to the change of temperature between in-doors and out-of-doors, may, under unfavorable conditions, be followed by injurious consequences.

The proper method of inhaling gases and vapors from an inhaler must be acquired by the patient, otherwise the vapor will merely be drawn into the mouth and reach the pharynx, and if it mixes at all with the air in the lungs, will do so by diffusion ; but with a little effort the manner of effecting penetration into the lungs can

* Coxe, On Inhalations, Philadelphia, 1845, pp. 90, 116.

be readily acquired. That it is no easy matter to inhale a vapor, and that, consequently, when stramonium and the like are smoked, instead of being carried into the lungs by the inspiratory current, they impress the system sympathetically or otherwise by their effect upon the mucous membrane or on the terminal nervous distribution of the pharynx, can be made evident by attempting to inhale the smoke from an ordinary segar. As usually smoked, none of the smoke passes the glottis, and when the attempt to inhale is made, it will be found to require considerable effort, and induce a paroxysm of cough with disagreeable sensations, even in the persons of inveterate smokers. A volume of smoke can be retained in the mouth for a considerable time without embarrassing respiration; and this is proof positive that inhalation is being carried on behind the velum through the nares. When the nostrils are compressed the effect is different.

If the smoke, after having been taken into the mouth, be blown into a wide-mouthed vessel, a tumbler for example, and a deep inspiration be made of the smoke as it is playing about in the receptacle, the lungs will become charged, under subjective phenomena promptly perceptible to the patient. When, therefore, vapor has been drawn into the mouth from an inhaler, a deep inspiration should follow the suction effort, so that the air, in entering the lungs, will carry a portion of the vapor with it. If this cannot be done, the vapor or smoke may be blown into a tumbler and inhaled from that. If the vapor is forced into the mouth mechanically, by compressed air, from a compression bellows for instance, it can be inhaled much more readily than by the mere effort

of aspiration. This method is of advantage in administering inhalations to debilitated or bedridden patients. Care must be taken to keep the compressing apparatus in good order, so that it shall not suck up any of the fluid instead of forcing air through it.

The importance, then, of seeing that patients inhale properly is self-evident, for if they are merely directed to inhale, and not taught how to do so effectually, in many instances the attempt will be futile, and the method of course fall into disrepute.

One great mistake often made in administering inhalations, is in having the water from which the vapor rises too hot. Usually a temperature of from 110° to 120° F. is all that is requisite to disengage the volatile ingredients of vegetable substances, and the greater the volatility of the substance to be used, the less the degree of heat that will be required.

Dr. John Harwood,* of London, endeavored by experiment to determine the best temperature for inhalation, as also the temperature of the water necessary to produce the desired temperature of inhalation. This he did by retaining the bulb of a delicate thermometer in the vapor within the inhaler, and successively passing a volume of twenty cubic inches of atmospheric air at a given temperature through the instrument, this volume of air being similar to that which is received by the lungs during diminished or impaired respiration; and the passage of the current through the inhaler was conducted in the succession of the inspirations of breathing. It was thus ascertained that atmospheric air of 57° F.,

* On the Practical Use of Inhalations, etc., London, 1839.

when combined in its passage through the inhaler, with the vapor arising from

Water at 100° afforded an inhalation of 79°
" " 110° " " " " 84°
" " 120° " " " " 88°
" " 130° " " " " 93°
" " 140° " " " " 99°
" " 150° " " " " 104°

Dr. Harwood recommends water at from 110° to 135° F. as the best scale for ordinary purposes, 130° being the most suitable temperature.

By taking the mean between the temperature of the apartment, and that of the medicated fluid, we can estimate the temperature of the vapor. It is not well, except the object be to promote active secretion, to exceed the normal temperature of the air in the lungs.

Many volatile substances may be inhaled from any simple vessel, as a bowl, jug, or tea-pot; the patient breathing directly over the vessel, or through a funnel with a wide tube. When it is desired to impress the system more fully, a cloth may be loosely thrown over the head, if necessary, to insure more copious respiration of the vapor; care being taken that due access of the air is not impeded. This method of inhalation sometimes induces congestion of the head and face, and, therefore, should not be carelessly recommended. Inhalers require a special mouth-piece to be placed within the mouth or over it, or a nozzle to be inserted into the nostril. This mouth-piece may communicate directly with the vessel, or what is almost always preferable, be attached to it by means of flexible tubing. All inhalers consist essentially of a reservoir with two openings; one to admit the entrance of air, and the other to afford it egress after im-

pregnancy with the vapor. The latter opening may constitute the mouth-piece itself, or communicate with it by rigid or flexible tubing. In some inhalers the opening for air is closed by a perforated cork, through which a tube of glass, metal, or hard rubber dips down nearly to the bottom of the vessel, so that the air must pass through the fluid in the body of the inhaler before it reaches the exit or inhaling tube.

The mouth-piece of the inhaling tube may be simply tubular, so as to be placed within the mouth, or terminate in a wide funnel-shaped orifice, so as to be placed in front of the mouth. The latter form is often better adapted to mere inspiration, the former requiring in some measure a combined effort at suction, which complicates the process, and renders it too fatiguing for debilitated and bedridden patients.

INHALERS.

There are more varieties of inhalers than are worthy of mention. A description will be given of a few of those most deserving of notice.

The inhaler devised by John Mudge,* the type of most modern inhalers, consists of a pewter mug (Fig. 1) of the capacity of a quart, with a hollow handle. The interior of the handle communicates below with the interior of the vessel, and a number of perforations in the upper part of the handle permit the ingress of the external air during inspiration through the apparatus. A tightly fitting lid of some thickness covers the mug. A central perforation in this lid permits the attachment of a flexible tube through which the patient is to inhale;

* A Radical and Expeditious Cure for a Recent Catarrhous Cough, etc., London, 1778.

while a second perforation incloses a ball-valve of cork, so placed as to permit the egress of air, but prevent its ingress.

FIG. 1.



Mudge's Inhaler (from Mudge).

a, perforated plate to cover the orifice of exit for expired air; *b*, cork valve; *c*, tube of orifice through which the air is inhaled; *d*, flexible tubing; *e*, mouth-piece; *f*, orifices for entrance of air.

The mug being filled to two-thirds of its capacity, the water of course rises in the handle to the same level; and, therefore, when the patient inspires through the flexible tube, the air rushes through the handle of the mug into the water, and out through the inhaling-tube. When the patient expires through the tube, the air of expiration passes into the free space beneath the cover, and is expelled out of the second perforation in the cover, lifting the cork-valve in its egress. All the

holes are large, so as to afford the greatest freedom of respiration, both acts of which are performed through the apparatus without removal of the mouth-piece.

FIG. 2.



Wolfe-Bottle Inhaler.

FIG. 3.



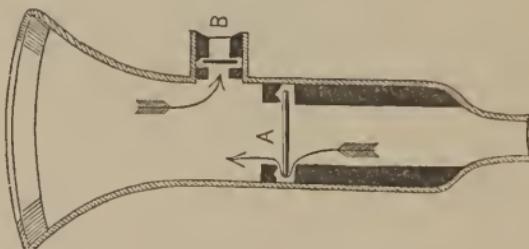
Simple Modification of Wolfe-Bottle Inhaler.

An efficient inhaler in common use is composed of a three-necked Wolfe's bottle (Fig. 2). Two of the corks are perforated. Through one an air-tube passes nearly to the bottom of the vessel; through the other the inhaling-tube passes a short distance. When in use, the bottle being partially filled with liquid, the external air passes through the straight tube into the liquid, and then out of the bent tube, to which tubing and mouth-piece may be attached. A wide-mouthed bottle, with a doubly-perforated cork (Fig. 3), answers the same purpose, and can be arranged extemporaneously at short notice. The bottles should be of the capacity of a quart, and the tubes of large calibre, so that respiration may take place with as little impediment as may be. The great defect in most modern inhalers is that the tubes

are insufficient in calibre for the air to be drawn through them by mere aspiration, so that an accessory movement of suction becomes requisite.

In using these more simple inhalers, the tongue can be placed against the end of the tube in the mouth during expiration, so that the expired air passes out through the nostrils, or otherwise the mouth must be removed from the instrument at each expiration, in order that the expired air shall not pass into the inhaler. Of late years, mouth-pieces to inhalers have been provided with valves, which permit the medicated air to pass into the mouth in inspiration, and direct the expired into the atmosphere, so that none of it contaminates the air entering the reservoir or apparatus. One of the best of these contrivances has been devised by Dr. Beigel, of London,* the accompanying sketch of which in section (Fig. 4), sufficiently explains its construction: "The two valves (A and B) are made of vulcanite, and, acting

FIG. 4.



Beigel's Mouth-Piece (from Beigel).

extremely easily, close and open with great precision. It is obvious that the inhalation with each inspiration—during which the valve B gets closed—takes place in

* On Inhalation as a Means of Local Treatment of the Organs of Respiration by Atomized Fluids and Gases. London, 1866, p. 75.

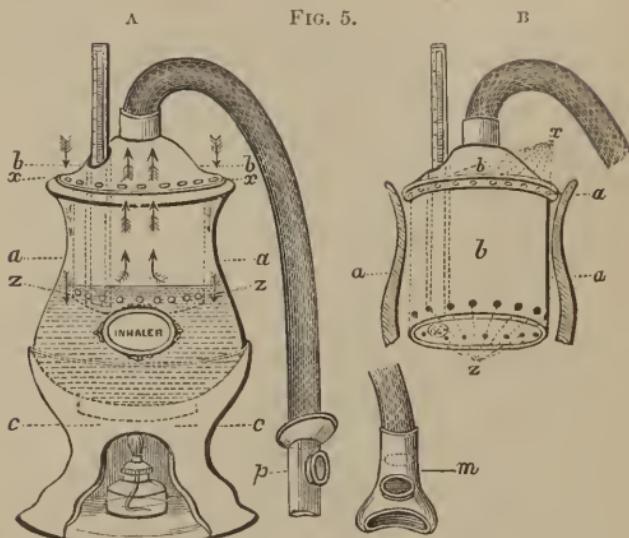
the direction of the arrow at A ; while, during expiration, A closes, and the expired air escapes in the direction of the arrow at B."

The apparatus of Sir Charles Seudamore is substantially on the same principle as that of Mudge. It is a glass vessel with a double neck; though a wide-mouthed bottle, with two perforations through the closely-fitting cork, will answer the same purpose. Sir Charles directs that the water in the inhaler should be about an inch in depth, and to this the mixture to be inhaled must be added. He deems it important that the bottle should be large and the tubes capacious. The tube issuing from the bottle should be upright, passing gradually into a slight curve, so that the vapor should not be much cooled during its egress. The ingress tube should dip very close to the bottom of the vessel, that all the air introduced may become impregnated. The patient should be desired to inhale by a combination of a suction effort and a pretty deep inspiration; then to drop the under lip from the mouth-piece and make a free expiration, and thus continue the process, pausing occasionally to avoid fatigue, which would more certainly ensue by breathing quickly, or using an inhaler with small tubes, or containing too large a quantity of water.

In fact, most of the inhalers in use are modifications of Mudge's. They are made of glass, earthenware, or metal. The latter are stronger, but liable to corrosion, so that they cannot be employed promiscuously with any agent; the others do not have this disadvantage, and can be kept more cleanly, but they are liable to fracture, and to become cracked in applying or withdrawing heat.

One of the most complete instruments of its kind is

the eclectic inhaler of Mackenzie* (Fig. 5), composed of porcelain.



Mackenzie's Eclectic Inhaler (from Mackenzie).

"The inhaler consists of three parts—*a*, *b*, and *c*. *a* is an open vase, and is essentially the containing vessel, into which the hot water and medicated solution are put. It is shown in A, with a pint of water in it; above the water-line is a large space for the steam. *b* is a kind of lid, resembling an inverted tumbler. It is shown in A, forming the lid of the containing vase, and in B with the sides of the vase drawn diagrammatically. The bottom of the tumbler forms the covering of the vase, and the sides of the tumbler dip down into it, leaving an air-chamber between the two parts. When the vase has its proper quantity of water, the sides of the inverted tumbler or lid dip down only about half an inch below the water-line. The circumference of the lid

* The Pharmacopœia of the Hospital for Diseases of the Throat. London, 1872, p. 68.

is perforated with small holes, as seen at *x*, and the circumference of what would be the rim of the tumbler is also perforated in the same way at *z*. The apertures, both above and below, communicate with the air-chamber. When the patient inhales, air rushes through the various holes above at *x*, then through the air-chamber, again through the medicated fluid, and finally up to the mouth-piece, as shown by the course of the arrows. In the centre of the upper surface of the lid is a projecting nozzle, to which is attached a flexible tube, provided at its extremity with a double-valve earthenware mouth-piece. This mouth-piece may be either pipe-shaped (*p*) and held in the mouth, or it may terminate in a large oval cavity (*m*), into which the mouth is introduced. There is an opening in the lid, through which a thermometer, registering high temperatures, passes into the water.

"*c* is a stand, on which the vase rests, and is made hollow, so as to hold a spirit-lamp."

Carrick has modified this inhaler by using a metallic vase, and covering the perforated cylinder with flannel. It is smaller than the eclectic inhaler, and requires much less water; and the thermometer bulb is in the steam space. In the only one I have seen the thermometer was very inaccurate.

In another variety of inhalers, provision is made for placing a spirit-lamp beneath the vessel, so as to maintain the evolution of the vapor and the temperature during the entire time of the inhalation. One of the simplest and best of these is that of Mandl* (Fig. 6).

It consists of a globular glass vessel with two tubu-

* *Traité pratique des maladies du larynx et du pharynx*, Paris, 1872, p. 609.

lures in the upper portion; one simply to admit the air, and the other, longer, to give attachment to the flexi-

FIG. 6.



Mandl's Inhaler or Fumigator (from Mandl).

A, stand ; B, lamp ; C, support ; D, reservoir ; E, orifice to admit air ; F, orifice for attachment of flexible tubing ; G, wooden connection by which to hold tube ; H, additional tubing for mouth-piece.

ble tubing which carries the mouth-piece. It rests on a stand over a spirit-lamp. The inspired air as it passes over the vapor becomes impregnated with it, and the expired air escapes by the opening of entrance. The vapor being evolved by heat there is no necessity for an air-tube to dip into the fluid. The amount of heat

neecessary to evolve the vapor is regulated by altering the size of the wiek, or by the oeeasional removal of the lamp.

A tubulated retort answers the purpose perfectly. Waldenburg,* imitating the principle employed by Hippocrates, closes the tubule of the retort with a stopper while the vapor is being evolved, so as to prevent aeeess of the air into the retort itself, and leads a tube from the beak of the retort into a cylindrieal mouth-piece of large orifice. The vapor becomes mixed with air in this cylinder, and there beeomes cooled and condensed. I have often used a mouth speculum for the same purpose, leading the free extremity of the inhaling tube within the funnel-shaped portion, where the patient holds it gently between two of his disengaged fingers. In this way the outer air enters the funnel around the delivery tube, and is there mingled with the gas or vapor after its escape.

Charrière, of Paris, has constructed what appears to me to be an excellent apparatus for supplying vapors for inhalation in large volume.† The vapors are evolved in a vessel by means of a spirit-lamp. A flexible tube as capacious in calibre as the reservoir itself surmounts the latter, and terminates in a mouth-pieee whieh eovers the mouth.

Dr. John Snow, of London, contrived an inhaler especiaially adapted for the inhalation of opium, but also applicable to many other solid medicines. It is made chiefly of tin, and consists of a cylindrieal chamber, between four and five inches in diameter, and three or four

* Die locale Behandlung der Krankheiten der Athmungsorgane, Berlin, 1872, p. 584.

† Gaz. méd., Paris, Jan. 1850, p. 53.

inches deep, under the centre of which a spirit-lamp is placed. The bottom of the inhaler consists of a thin piece of talc, on which is placed a small capsule of Berlin ware, for the purpose of holding the extract of opium. A porcelain funnel-holder, which is placed on the talc, keeps the capsule exactly over the flame of the lamp. The talc allows sufficient heat to be transmitted to the opium, without conducting it to the sides of the inhaler, and, consequently, the air which is inhaled is not unduly heated. The lid of the inhaler is movable, and it is provided with a delicately balanced valve for the admission of air, and is connected to a face-piece by means of an elastic tube of wide calibre. This face-piece covers the mouth and nostrils, and is a modification of that of Hawksley. It is flexible, the sides and margin consisting of thin sheet lead, lined with oiled silk and covered with leather, with an expiratory valve which can be moved more or less to one side from the opening it covers, so as to admit unmedicated air whenever the vapor feels too pungent.

Langlebert's apparatus is a ring-shaped copper vessel, the cover of which is pierced with four holes, through which the vapor of water escapes when the water in the vessel is heated by a lamp. The flame of the lamp passes through the centre of the vessel, and thus volatilizes the mercury or other substance contained in an iron capsule placed above the orifice for the passage of the flame. The substance volatilized is thus mingled with warm watery vapor, a circumstance of considerable practical importance in some cases, as in the diffusion of vapors of tar and other substances.

Fig. 7 represents Bumstead's Calomel Vaporizer, which can be used for other substances also. Water is

placed in the ditch at top, which surrounds the receptacle for the calomel, the vapor of which thus becomes mingled with the vapor of water.

FIG. 7.



J. REVIDERS - CO

Bumstead's Calomel Vaporizer.

A special sort of intra-oral inhaler was introduced by Prof. Max Langenbeck,* consisting of a flattened globe, of boxwood or ivory, varying in diameter from three-quarters of an inch to an inch and a half, formed of two halves, which are screwed together, after some medicated cotton, wool, or sponge has been placed in the interior; a number of holes on each side permitting the passage of the air. The instrument is placed partially within the mouth, the lips of which compress the projecting portion. Prof. Langenbeck employed this instrument for treating many general affections by inhalation, as well as affections of the respiratory organs themselves.

An instrument virtually the same, but made of hard rubber, has been contrived by Dr. M. S. Buttles,† of

* Deutsche Klinik, 1861, No. 13, p. 129.

† Med. Record, 1866, p. 44.

New York, to which a rubber tube may be attached, so that the instrument may be entirely concealed within the mouth, the tube remaining outside to permit access of atmospheric air. These instruments can be modified for insertion into the nasal passages, in treating nasal or naso-pharyngeal affections.

Dr. Pomeroy,* of New York, has modified this instrument, by substituting a reservoir of glass (Fig. 8), so as

FIG. 8.



Pomeroy's Inhaler.

to permit the use of agents which would act upon hard rubber.

Dr. A. P. Merril, of the same city, devised a very elegant affair of hard rubber on the same principle, much of the shape of a lead-pencil, designed especially for inhalations through the nostrils.

An ordinary tobacco-pipe answers the purpose fully. This method is adapted only for substances volatile at ordinary temperatures. Pipes of glass or metal are sometimes used for cold inhalations.

Solutions of chlorine, iodine, tar, the balsams, turpentine, preparations of camphor, etc., may be diffused in any quantity through the air of an apartment by means of various contrivances. Dr. Corrigan† devised

* Med. Record, 1866, p. 44.

† Observations on the Exhibition of Remedies, in the Form of Vapor, in Pulmonary Diseases; with Description of a Diffuser for the Administration of Iodine, Chlorine, etc. Dublin Jour. Med. Sci., 1834, 43, p. 94, illustrated.

an apparatus for this purpose, fulfilling the following requisites: "1st. That the apparatus should be simple in its construction and easily kept in order; 2d. That it should be capable of keeping up a supply of vapor for any length of time, and that the evolution of the vapor should be steady, and should be easily regulated; 3d. That it should also furnish a sufficient supply of aqueous vapor, to prevent any irritation of the larynx, or lining membrane of the air-tubes; and 4th, and most important of all, that its employment should entail neither trouble nor fatigue on the invalid.

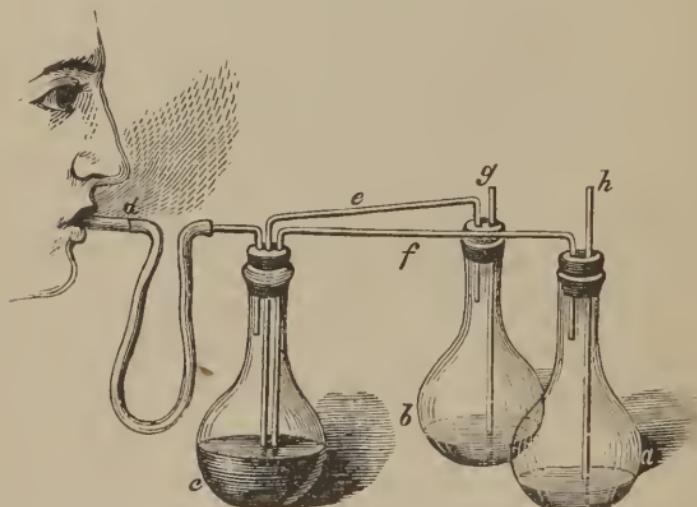
"This apparatus consists of a light, open, iron-wire frame, about eighteen inches high, at the bottom of which is a spirit-lamp; at the proper height above this is an evaporating porcelain dish, about six inches in diameter; and above this is a glass globe, with its neck downwards. In the neck of the globe is a cork, bored, and through the opening is drawn, moderately tight, a short plug of cotton wick, such as is used in a spirit-lamp; in the glass globe, opposite the neck, a pin-hole is drilled, to allow air to pass in, according as the fluid within drops out through the neck. To use it, the porcelain dish is filled with hot water, the spirit-lamp is lighted, and as soon as the water in the dish has begun to boil, the glass globe containing the tincture of iodine (if this be the substance used) is placed in position. The rate at which the fluid in the globe shall percolate the cotton wick and drop into the hot water beneath is easily regulated. If it should not drop with sufficient rapidity, one or two of the threads of cotton may be removed. Should it drop too rapidly, this is corrected by pressing in the cork more tightly, or introducing one or two additional threads of wick."

In the absence of this apparatus Dr. Coxe* found a common nursery lamp to answer very well.

An apparatus devised by W. G. Walford,† for evolving chlorine gas, consists simply in a ground stopper introduced into the tube of a funnel, so as to allow fluid to pass through guttatum. If muriatic acid be allowed to drop on to a quantity of chloride of lime, at the rate of three or four drops a minute, chlorine gas will be evolved.

Lewin, of Berlin, devised an apparatus for evolving the vapors of sal ammoniac in a nascent state without the employment of heat or fire.

FIG. 9.



Lewin's Apparatus for the Inhalation of Nascent Vapors of Sal Ammoniac. (From Lewin.)

a, glass vessel, containing strong aqua ammonie; *b*, glass vessel containing muriatic acid; *c*, glass vessel containing distilled water, slightly acidulated; *d*, rubber tubing, to which is attached the mouth-piece; *e*, *f*, connecting glass tubes; *g*, *h*, glass tubes for admittance of atmospheric air.

This apparatus (Fig. 9) consists of a series of three

* Op. cit., p. 95.

† The Lancet, Dec. 5th, 1874, p. 823.

Wolfe's bottles. One of these contains a little caustic water of ammonia, another a little pure muriatic acid, and the third bottle, which is partially filled with water, receives a tube from each of the other bottles, these tubes reaching to the bottom of the water, while from a third opening in the cork the vapor extrudes through an exit tube, to which a mouth-piece is attached by india-rubber tubing. Now, as the effort of inspiration draws the liquids from the first two bottles into the third bottle, their ingredients combine to form the sal ammoniac vapor, which, during its passage through the water, becomes cleansed of impurities. If it is desired to medicate the nascent sal ammoniac with creasote, or an oleobalsamic mixture, or bitter-almond water, or the like, all that will be necessary will be to add it to the water in the third bottle.

ATMOSPHERIC AIR.

Systematic inhalation of atmospheric air is often of great therapeutic service. Every one is aware of the benefits derived from residence in mountainous regions, and from the pedestrian tours and other gymnastic exercises to which pugilists are subjected during training, which, developing their respiratory capacity, increase their strength and powers of endurance.

In individuals with weak lungs, that is to say, with deficient normal respiratory capacity, in those of sedentary habits, whose pulmonary organs are rarely adequately aerated, the habitual employment of a number of forced inspirations of fresh air at stated hours, will soon exert a beneficial influence. The result will be facilitated by forcibly straightening out the shoulders, either voluntarily or with the aid of an assistant, during

the inspiration, which should be slow and through a small oval aperture, or through a tube of some kind, round which the lips are closed; the position of the arms being maintained during the inspiration. Running, leaping, dancing, and the like, induce a demand for increased and deepened inspiration, which is very efficacious in instances where such violent exercise is not contraindicated. I have for a long time, in suitable cases of deficient aeration of the lungs and expansion of the chest, been in the habit of advising the daily use of the jumping-rope, a few minutes at a time, "back-door," as the children term it. In young ladies, especially those of sedentary habits or occupations, or those kept too closely confined at school or at the piano, I have found this exercise of admirable utility in promoting due expansion of the lungs and development of the chest, as well as in overcoming a disposition to round shoulders. As a matter of course, corsets, and every other bandage or article of apparel which constricts the chest or abdomen, should be removed during the exercise.

Systematic forced respiration of atmospheric air, through an inhaler or a long tube, three times a day, for half an hour each time, has been highly recommended by Dr. Ramadge,* in the early stages of consumption, as a means of enlarging the chest, and increasing the permeability of the lungs; the increase in the natural respiratory murmur becoming more distinct at the end of a few weeks. This author attached but little value to the substances inhaled; but inasmuch as patients are more willing to receive into their lungs something having

* Consumption Curable, London, 1836, 3d ed., p. 97.

sensible properties, rather than pure atmospheric air, he was in the habit of recommending a handful of hops, a little ether, vinegar, or a tablespoonful of spirits of turpentine to be added to the warm water in the inhaler.

Forced expiration and inspiration of common air has been found a successful expedient in terminating a paroxysm of spasmodic asthma.

Dr. J. S. Monell,* of New York, has recorded his own ease:

In December, 1865, about nine o'clock one evening, he was having a severe attack of asthma, to which he had been subject for fifteen years. He placed himself standing at the foot of his bed, with his arms folded upon the foot-board for a pillow, the forehead resting upon the folded arms, and the feet placed at a sufficient distance to make a partial semicircle of the body. While laboring severely for air, the thought occurred to him to cease breathing for a few seconds. He did so, and after several trials experienced some relief. He then expired all the air that it was possible for him to do, after which he determined not to inspire again until he found it absolutely necessary. He succeeded in waiting several seconds, then inspiration was carried to its fullest capacity, and retained with great effort for many seconds. This act of forced expiration, waiting, thorough inspiration, and again waiting, was continued for some fifteen minutes, and to his delight, the spasm was perfectly relieved. He has since relieved several similar attacks by the same method, in less than two minutes. He has advised this course for many others, and their testimony has been uniformly satisfactory, except in one instance, that of an aged lady with heart disease. It requires a great effort on the part of the patient to perform this act. The first attempt at retaining the inspired air during the asthmatic attack, will cause the patient to think he cannot continue it, but perseverance will soon delight him with relief from the spasm.

I have frequently prescribed this experiment, and the results have been encouraging in a number of instances. This method is similar to that employed by Laennec,

* The Medical Record, August 15th, 1866.

according to whom,* if an asthmatic patient be induced to hold his breath for a short time, or to count aloud as many numbers as possible without stopping, and then quietly to commence breathing again, the spasm appears to be in a manner surprised into relaxation, and the air can be heard entering all parts of the lungs for the next breath or two; after which, the ordinary state of things returns.

The inhalation of cold or cool atmospheric air, as a remedy in pulmonary diseases, was advised by Dr. C. Drake, of New York.† He found the method of most value in chronic catarrhs of long standing. He employed these inhalations at temperatures varying from 32° F. to 3° or 4° below zero, and found them to afford comfort, relieve cough, and render the pulse slower and fuller.

Dr. Ramadge‡ was, at one time, in the habit of resorting, in the treatment of consumption, to the inhalation of air artificially cooled, for the purpose of exciting an intercurrent catarrhal inflammation of the mucous membrane of the air-passages, the influence of which, he claimed, often led to the recovery of the patient. Dr. Coxe, of Baltimore,§ confirmed this result in his own experience.

Prof. Langenbeck placed ice in the reservoir of his oral inhaler,|| for the purpose of cooling the inspired air in cases of haemoptysis, in pulmonary consumption, and in fevers.

Much more recently,¶ the inhalation of cold and dry

* Wood's Practice, Philadelphia, 1858, 1, p. 883.

† Am. Jour. Med. Sci., 1828, vol. ii, p. 53, and vol. iii, p. 53, with an illustration of a refrigerator.

‡ Op. cit., p. 101. § Op. cit. || See p. 29.

¶ Med. Times and Gaz., January 16th, 1869, p. 69.

air has been recommended as a remedy for the condition associated with separation of fibrin from the blood in inflammatory diseases. This air, it is stated, will bring down the temperature several degrees.

CONDENSED AND RAREFIED AIR.

The influences exerted upon the human economy from rarefaction of the atmosphere at high altitudes have long been known. Respiration and heart-action are accelerated, while there is an afflux of blood to the periphery of the body, leading to hyperæmia and congestion, sometimes eventuating in hæmorrhage from mucous outlets, as the nose, mouth, and conjunctiva. There is also a degree of lassitude independent of exertion.

The influence of condensed air upon animal and vegetable life especially attracted the attention of scientific men in the latter part of the eighteenth century; and the results of certain experiments upon animals led to the suggestion that the respiration of compressed air might be beneficial in certain cases of disease. To these have been added the observations of the effects of temporary sojourn in diving-bells and at the bottom of deep mines.

A communication to the Parisian Academy of Sciences was made on this subject by E. Tabarie, on December 7th, 1832,* and in August, 1835, M. Junod reported to the same body the results of his own experiments upon the human organism. Under the directions of Tabarie, at a later date, dating from 1838, the method was employed in the treatment of disease by Pravaz, Bertin, of

* Comtes-rendus, t. vi, p. 896.

Montpelier, and Milliet, of Lyons—who reported some cases of phthisis apparently benefited in the first and second stages—and others.

Tabarie's apparatus consisted of a wrought-iron spherical chamber, capable of accommodating a dozen patients, into which air was forced by a steam pump to the pressure of from one-half to two-thirds of an atmosphere. An arrangement attached to the apparatus afforded egress to the air expired by the patients. Each sitting lasted two hours, during the first half hour of which the requisite pressure was gradually produced, and, after having been maintained for an hour, it was gradually withdrawn during the last half hour.

Milliet* records the results in twenty-two cases, comprising asthma, congestion of the lungs, emphysema, hepatization, phthisis, bronchial catarrh, chlorosis, hooping-cough, laryngo-tracheitis, broncho-tracheitis, bronchitis and chronic pneumonia.

Bertin† recorded, in 1855, thirty-five observations in bronchitis, acute and chronic, chronic angina with aphonia, chronic pharyngitis, aphonia, bronchial catarrh, pulmonary oedema, emphysema, asthma, haemoptysis, chronic pneumonia, and phthisis.

Sandahl, of Stockholm, reported, in 1862,‡ the statistical observations of three hundred and fifty-three cases, of which there were one hundred and forty of

* *De l'air comprimé comme agent thérapeutique*, Lyon, 1854.

† *Étude clinique de l'emploi et des effets du bain d'air comprimé dans le traitement de diverses maladies*, Paris, 1855. Also, *Étude clinique de l'emploi et des effets du bain d'air comprimé dans le traitement des maladies de poitrine, notamment dans le catarrh chronique, l'asthme, et la phthisis pulmonaire*, Paris, 1868, pp. 774. Reviewed in *Gaz. hebd.*, 1868, No. 50, p. 794.

‡ *Om Verkningarne of fortädat Luft*.

diseases of the larynx and trachea, seven of pneumonia, twenty-two of asthma with emphysema, thirty-one of tuberculosis, five organic valvular insufficiency of the heart, ten of anaemia, and thirty-five of aural catarrh. Subsequently,* Sandahl has recommended the use of this agent in the treatment of hooping-cough.

Attempts were soon made to establish a physiological basis for the therapeutic employment of compressed air, and the resulting labors of a number of investigators have been published in the medical periodicals and in monographs.

The subject was most thoroughly studied by von Vivenot, Jr., who has presented† everything of value up to the appearance of his own work.

From these memoirs we learn that the first result of inhaling condensed air is a prolongation of the respiratory acts, which continues, in a slight degree, for some time after leaving the compressed atmosphere. The sojourn for one or two hours daily in an apparatus, under an extra pressure of about three-sevenths of an atmosphere, will gradually diminish the frequency of respirations some three or four in the minute. The lung capacity is increased at the same time, chiefly by greater descent of the diaphragm. Inspiration becomes easier and more rapid, expiration slower and more laborious. The frequency of the pulse undergoes diminution from four to seven beats in the minute, but soon resumes its normal rate in the normal atmosphere. The mass of

* *La Tribune méd.*, 1868, p. 558; see also *Jour. f. Kinderkr.*, 1867, Nos. 11 and 12; *Gaz. méd.*, Strasbourg, 1868, p. 118.

† *Zur Kenntniss der physiologischen Wirkungen und der therapeutischer Anwendung der verdichteten Luft. Eine physiologisch-therapeutische Untersuchungen.* Erlangen, 1868.

blood is driven from the periphery of the body towards the central organs. Thus gaping, disposition to somnolence, and the like, are induced in consequence of excess of blood in the brain. The secretion of urine is augmented. The senses of touch, taste, and smell become obtunded, and the voice acquires an unnatural, metallic clang. The only uncomfortable sensation experienced by the healthy subject is said to be a sense of pressure upon the tympanic membrane, which can be relieved by the well-known procedure of Valsalva for inflating the Eustachian tube.

The physiological effect of compressed air being to drive the blood from the periphery, it follows that congestions, tumefactions, inflammations, excessive secretion, and the like, at the peripheral portions of the circulatory system should be relieved by subjection to the treatment. The ease afforded to respiration suggests its employment in cases with which dyspnoea is associated; and we find its chief application, in fact, in pulmonary emphysema, asthma, and chronic bronchitis. The augmentation of vital capacity of the lungs acquired by the process, suggests its employment in cases of insufficient expansion of thorax, and therefore in early, non-febrile cases of phthisis and tuberculosis.

Tabaric's apparatus was modified by Gustav Lange, so as to admit of rarefaction of the air also; and in this, and various other modifications, it has been extensively employed in a number of continental cities and resorts for invalids. In Great Britain, and still more so in America, hardly any attention at all has been paid to the subject in a therapeutical point of view.

Dr. J. Burdon-Sanderson, of London, in describing*

* Practitioner, October, 1868, p. 221.

the compressed air-chambers of the brothers Mack at Reichenhall, Bavaria, favors the view that compressed air exercises a very marked sedative influence both on the circulation and the respiration. "The pulse is retarded, while the respiration not only becomes less frequent, but appears to be performed with diminished effort; and it is remarkable that these effects, although they are most obvious during the time that the patient is under pressure, do not entirely cease, when the normal conditions are restored." The cases in which compressed air is useful, are those of chronic bronchitis with emphysema, the dyspnoea attending which is due to the series of changes, consequent on dilatation of the right heart, engorgement of the venous circulation, and impairment of the pulmonary circulation.

"Dr. Lange maintains that the efficacy of the compressed air principally rests upon the blood being more richly supplied with oxygen, and that a healthier nutrition is the immediate consequence of it. He proves that by the application of compressed air, a considerable increase of the negative pressure of inspiration and of the positive pressure of expiration takes place, whereby the power of the muscles of inspiration becomes greater, the pressure of the blood in the aortic system is lowered, and the frequency of the heart's pulsation diminished. The animal heat lowers likewise after the application of a compressed air bath, the organs of digestion are placed in a better position, whilst the appetite increases, and the functions of the bowels are performed with greater ease. Increase in secretion of the urine has been observed in most of the cases."*

Dr. Von Liebig, of Reichenholt, as the result of his experiments upon compressed air, finds, among other

* Beigel, op. cit., p. 71.

things, that its inhalation has not in itself any very natural effect on the production of carbonic acid. Any increase of expired carbonic acid coincides with a greater inspiration of atmospheric air, and the quickness of respiration has a much greater effect in producing carbonic acid than its depth. The number of respirations being reduced under increased pressure, and increased under diminished pressure, it seems probable that the quantity of carbonic acid expired may be greater under the latter circumstances. From his experiments on oxygen Dr. Liebig deduces the inference that there is undoubtedly increased absorption of oxygen under high pressure, relatively amounting to eighteen, and absolutely to twenty-two per cent.; and he attributes much of the success of the pneumatic treatment to this increased supply of oxygen in the compressed air.*

The therapeutic application of compressed, and likewise of rarefied air also, has become established upon a more practical and available basis, however, by the construction of transportable apparatus, in which the atmospheric pressure can be increased or diminished within certain limits at will. In residence at elevated altitudes, and in temporary sojourn in pneumatic chambers, not only are both acts of respiration performed in air at the same pressure, but the entire body is also subjected to its physical influence. Neither of these effects may be desirable. By means of suitable apparatus, however, rarefied or condensed air may be supplied to the respiratory surfaces alone, without subjecting the entire body to their influence; and, furthermore, one act of respiration may be performed in condensed, and the other in rarefied air, as may be deemed advisable under certain

* (Aerz. Int.-Bl.), The Lon. Med. Record, July 29th, 1874, p. 472.

diseased conditions. The treatment is no longer confined to any special locality or establishment, and is, therefore, within reach of patients at their own places of residence.

The first apparatus constructed for the sole purpose under consideration was devised by Ignaz Hauke,* of Vienna, but as it has become superseded by better contrivances, it retains, at present, its historic interest only. Hauke, at first, hoped to facilitate respiration in croup by the aid of this apparatus, but he found his contrivance inapplicable to the purpose. In emphysema, however, and subsequently in pulmonary consumption, he found this pneumatic treatment of great value; and its application has since been extended in modified forms of other diseases associated with impediment to respiration.

Dr. Berkart, of London, devised an instrument† for expiration into rarefied air, for use in the treatment of emphysema, his object being "to reduce the intravesicular pressure, and that resulting from it on the thoracic surface of the diaphragm." It is an expiration rather than an inhalation apparatus. The patient breathes through a tube in communication with the cylinder of an exhausting syringe, from which the air is to be suddenly withdrawn at the completion of an ordinary act of expiration; the object being to remove from the chest a greater amount of air than can be expelled by the unaided act of voluntary expiration. The tube and mouth-piece are provided with valves which conduct the currents of inspiration and expiration in the desired direction. The instrument is to be used twice a day, for a quarter of an hour at a time.

* Ein Apparat für künstlichen Respiration und dessen Anwendung zu Heilzwecken, Wien, 1870.

† The Lancet, Nov. 25th, 1871.

Dr. Dobell* has devised a "residual-air-pump," for pumping out the residual air in the lungs, as far as possible, in emphysema. It consists (Fig. 10) essentially of a mouth-tube with a valvular arrangement which allows freedom of expiration, but impedes inspiration to a certain extent, the nostrils being closed or

FIG. 10.



Dr. Dobell's Residual-Air-Pump.

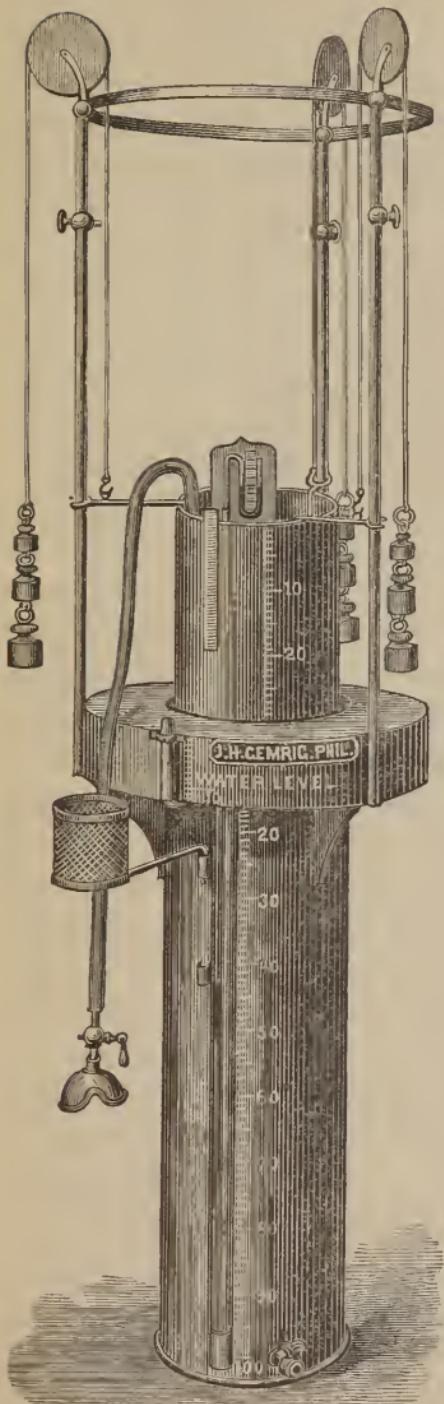
unused during the process. "In from three to six respiratory acts, the expiratory and reserve air is quite pumped out, and the diaphragm has risen to the greatest height of which it is capable. The patient is then obliged to open the mouth and take a deep inspiration, which he does much more freely than he could before using the instrument, and with a distinct sense of relief and comfort. He then closes his mouth upon the pipe-end, and repeats the operation." This little instrument is portable (it can be placed in the vest pocket) and simple, and is intended for the patient's own use.

One of the most complete contrivances for the administration of compressed and rarefied air, if not the very best, is the improved pneumatic apparatus of Professor Waldenburg,† modeled on the spirometer of Hutchinson,

* Brit. Med. Jour., Feb. 10th, 1872.

† Die pneumatische Behandlung der Respirations- und Circulationskrankheiten, im Anschluss an die Pneumatometrie, Spirometrie, und Brustumessung. Berlin, 1875, p. 150, fig. 5.

FIG. 11.



Waldenburg's Apparatus for Inhalation

and applicable to accurate physiological investigation, as well as to therapeutic purposes (Fig. 11).

It consists essentially of two cylindrical reservoirs of tin or sheetzinc: an outer one open at top, and an inner one open at bottom or inverted; the latter sliding readily within the former. Cords attached to the upper portion of the inner cylinder pass over pulleys and carry hooks for the attachment of weights, as may be required to draw the inner cylinder partially out of the outer one for purposes of rarefaction of the contained air; while on the other hand, for purposes of condensation, the weights are placed atop of the inner cylinder to press it down within the outer one, and thus compress the air. Sufficient water being poured into the outer cylinder, the air in the inner cylinder is shut off contact with the

exterior air, and being thus confined, may be subjected to rarefaction or condensation as the inner cylinder is elevated or depressed. The air thus rarefied or compressed is conveyed to the patient through a large tube to an oro-nasal mask which fits hermetically over the nose and mouth, so that the patient breathes the air from the inner cylinder. A stop-cock attached to the mask controls the passage of the air. A manometer is attached to the inner cylinder to denote the pressure, and a water-gange to the outer cylinder to indicate the water-level within. Finally, a graduated scale exists upon both cylinders, serving to measure the cubic contents of the air in either vessel. A spigot at the bottom of the outer vessel permits the water to be drawn off.

By means of this apparatus compressed or rarefied air can be inspired at will, on the one hand ; while, on the other, expiration can be made into rarefied or into compressed air, as may be desired. By a combination of two apparatuses, one act of respiration can be made in rarefied and the other in condensed air, or the reverse.

If it is considered expedient to combine the inhalation of vapor of water or other vapors with the compressed air, as suggested by Hauke, von Cube, and others, it can be accomplished, as von Cube has done,* by interposing a Wolfe's bottle, suitably charged, between the tube leading from the apparatus and the oro-nasal mask.

Domanski,† of Craeow, has proposed the inhalation of compressed air, charged with medicinal substances, in the treatment of bronchitis and phthisis. He recommends oil of turpentine, and also a one per cent. solution of carbolic acid. Such inhalations are said to be always

* Berlin, klin. Woch., 1874, No. 4.

† Berlin, klin. Woch., Jan. 4th, 1875; London Medical Record, Feb. 10th, 1875, p. 87.

well borne, and not to irritate the larynx. Five patients, who suffered from distressing cough and from copious expectoration, obtained immediate relief under this treatment. Also, in one case of phthisis, the vital capacity of the lungs is alleged to have increased from 2850 to 3100 cubic centimetres, and in another case from 2100 to 2300 cubic centimetres.

The bottle can also be used to contain a disinfectant, and thus disinfect the expired air of patients breathing into the apparatus; another point of no small importance when we consider the exposure to contagion, or at least contamination, to which patients are necessarily subjected, when an apparatus of this kind is used for one patient after another without cleansing. Separate mouth-pieces, for the same reasons, should be employed with certain patients.

The amount of compression employed for therapeutic purposes is not very great. Waldenburg* begins with a pressure of one-sixtieth of an atmosphere, and gradually increases to one-fortieth, seldom exceeding this amount. In delicate subjects he begins with one-eightieth of an atmosphere pressure, and gradually increases it by additional weights on the internal reservoir of one pound after another. The inhalations are best accomplished in the erect position. One cylinderful generally suffices for from fifteen to twenty-five inspirations, according to the vital capacity of the patient; but some will require from thirty to sixty inspirations to empty it, while others exhaust it in from ten to fifteen inspiratory efforts. Delicate persons consume from two to three cylinderfuls daily, with interruptions, and others from three

* Op. cit., p. 138.

to six. Each sitting occupies from ten to thirty minutes, inclusive of the periods of rest; and complete repose for fifteen minutes is recommended before and after the inhalation. The use of the apparatus is interdicted if the patient is overheated or somewhat exhausted from labor. The inhalations are usually taken once a day; rarely twice.

The entire pressure of the atmosphere on the inner cylinder of Waldenburg's apparatus equals about 1183 pounds, or in round numbers 1200 pounds; and the weight of the inner cylinder itself is about 10 pounds. Dividing 1200 by the number representing the desired pressure, we obtain the number of pounds of weights required to be attached to the inner cylinder. Thus, if an additional pressure of one-eightieth of an atmosphere is wanted, 15 pounds would be placed upon the cylinder (from which we would deduct the weight of the cylinder itself) to press it down; if the pressure is required to be reduced, a similar amount of 15 pounds would have to be hung upon the cords to draw it up (adding the weight of the cylinder, or 10 pounds additional); if we wanted to employ one-fortieth of an atmosphere, 30 pounds pressure, we would place 20 pounds on the cylinder for purposes of compression, or hang 40 pounds to the cords for purposes of rarefaction.

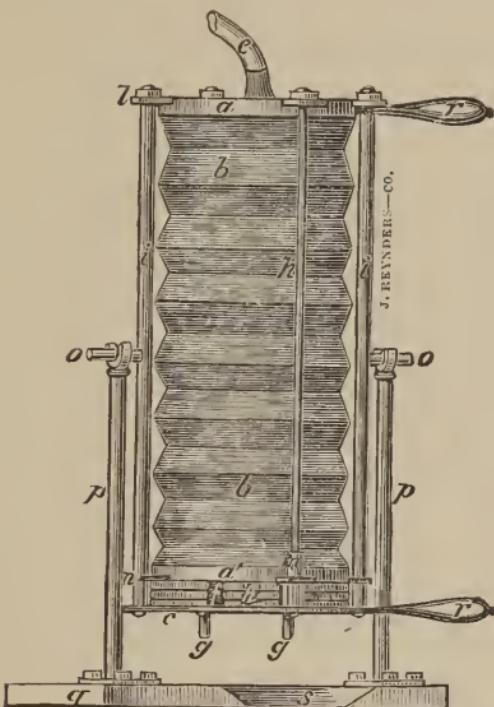
For further details concerning the employment of this apparatus we refer those of our readers who understand German to Waldenburg's recent volume, and those who cannot read German to a translation, in preparation, by Dr. Elsberg, of New York.

Dr. Ph. Biedert,* of Worms, has constructed an ap-

* Berliner klin. Woch. 1874, No. 29.

paratus (Fig. 12) on the principle of an aeoustic bellows or harmonicum, to one end of which weights are affixed.

FIG. 12.



Beiderst's Apparatus for Inhalation of Condensed and Rarefied Air.

The whole apparatus rotates on a swivel at its centre, so that the bellows are compressed when the weights are atop, and dilated when they are at the bottom. Dr. Rose, of New York, who reports some personal use of this apparatus,* describes it as follows:

"The bellows has the form of a cylinder, 50 centimetres in height, 22 centimetres in diameter, which is closed at the ends by boards ($a a'$) $1\frac{1}{2}$ centimetres in thickness, termed covers. Its walls (b) are made of leather, air-tight, and have the necessary strength to

* The Medical Record, N. Y., Aug. 28th, 1875, p. 577.

maintain their ordinary form against overpressure of air. The lower cover has a perforation near its front margin into which a rubber tube (*c*) is fitted air-tight, and when in use is prevented from collapsing by a spiral wire which it contains. Straps are fastened cross-wise to the upper cover for holding weights; pins being inserted which fit into holes in the weights and prevent their slipping. These weights are round plates of iron of the diameter of the covers of the bellows; two are $2\frac{1}{2}$ pounds each, and others 5 pounds each; 30 pounds go with every apparatus. When the bellows is expanded as much as possible, it contains a column of air, the diameter of which is upon an average 2 centimetres less than that of the covers, on account of the zigzag outline of the walls of the bellows. The pressure which the covers of the bellows must support is equal to that upon a circular plane 20 centimetres in diameter, or 314 square centimetres of area, which will be 648 pounds, taking 1033 grammes as the pressure upon a square centimetre. If the bellows is charged with 1 pound, the condensation of the air will be $\frac{1}{648}$; with 10 pounds it will be $\frac{1}{64.8}$; with 20, $\frac{1}{32.4}$; with 30, $\frac{1}{21.2}$. If the bellows is reversed, weights downward, and in this manner expanded, the cubic contents will be equal to the area of the cover multiplied by the height of the expanded bellows, $314 + 50 = 15,700$ centimetres.

"The other part of the apparatus is a stand of iron consisting of four opposite iron bars, two thinner (*h*) and two stronger (*i*), connected on top by a flat ring, the diameter of which is 24 centimetres. The lower ends of the bars are fastened to the lower cover of the bellows, which can readily be removed. The upper cover of the bellows can be moved up and down, and is kept

in line by guides running on the two upright thin bars of the stand. Guides are also attached to the body of the bellows, which slide on the two stronger upright bars. Small projecting pins (*o*) are attached to the centres of the larger bars, upon which the whole apparatus swings. These pinions are supported upon uprights (*p*) from a firm base of wood (*q*). Upon the pinions the apparatus can be turned by two handles (*r*), one of which projects from the ring above, the other at the lower end from one of the bars. This permits of a half turn of the apparatus backward.

"The machine is placed upright on the margin of a table, so that the tube will lie in a groove cut into the wooden base, and the desired quantity of weights is fastened to the upper cover of the bellows. If the upper end is turned down, the weights will sink and the bellows will fill itself with air. The bellows is then turned back, while the patient compresses the rubber tube (*e*) with his fingers until he is ready to inhale through the mouth-piece attached; he then gradually inhales the air as the weights compress the bellows. While the patient expires into the free air the bellows is filled again by turning, and the operation continued in this manner *ad infinitum*. For expiration into rarefied air the tube is compressed and the bellows turned weights downward; applying the tube to the mouth the air passes from the lungs into the partial vacuum produced by the expansion of the bellows. The bellows filled with the expiratory air is emptied by turning, while the patient inspires air at the atmospheric pressure, and the operation repeated.

"Finally, the patient can inhale condensed air from the partially filled bellows, and after turning the apparatus exhale directly into rarefied air."

The main advantage of this apparatus is its comparatively moderate price, which places it within the reach of patients for home use. The nature of its materials, wood and leather, renders it readily liable to become fouled by the emanations of the air breathed into it, and thus, under certain circumstances, to contaminate the air compressed for inspiration.

Another cheap apparatus for home use is one recently devised by B. Fränkel, of Berlin. The accompanying

FIG. 13.



Fränkel's Apparatus for Inhaling Condensed and Rarefied Air.

illustration (Fig. 13) and the subjoined account, are taken from the article of Dr. Rose, already referred to.

"As may be seen, it consists of the bellows of an accordion. On one side a metal tube is inserted two centimetres in diameter, which carries the mouth-piece; the latter may consist of an inflating rubber cushion, similar to a pessary. Fränkel recommends the sitting position

for using the apparatus. If the bellows is expanded by drawing the accordion apart, the air contained in it will be rarefied ; if it is compressed, the air is condensed. If the patient, during the expansion or compression, applies his mouth to the cushion the effect of the rarefaction or condensation of the air will communicate itself to the intrathoracic air. The apparatus is without valves ; as it is very easy to apply or withdraw the mouth from the cushion at the right moment ; any such arrangement as valves is therefore not necessary. If expiration is to be made into rarefied air, the mouth should be applied to the cushion and the bellows expanded. After the expiration the mouth is withdrawn from the cushion, and while inhaling the free air the patient closes the bellows, for expiring the apparatus is found empty and ready.

" All varieties of effects described with Biedert's apparatus can also be produced with Fränkel's apparatus, by the patient himself, without assistance. He can either inspire condensed air only, or he can inspire condensed air, and expire into rarefied air. -

" On the margin of the apparatus there is a centimetre measure, which plainly indicates by how many centimetres the wooden disks are separated or brought together. This shows the volume of air which has been drawn into or expelled from the apparatus. The apparatus is 35 centimetres in height, and 16 in breadth. If the foldings are considered, the bottom area will be $15 \times 34 = 510$ square centimetres. The expansion of the apparatus of one centimetre, according to the measure affixed, would correspond with 510 centimetres of volume.

" Fränkel considers the attachment of the dynamometer to his apparatus as unnecessary.

"The air from this apparatus is more completely and more fully perceived by the lungs, and with less modification of its original pressure than by any previous invention, due to the shortness of the breathing-tube. All excess of action is avoided, as it is worked by manual force only, Fränkel having found that with his greatest efforts he could not condense the air above $\frac{1}{8}$ of an atmosphere, nor the power of suction above $\frac{1}{20}$ atmosphere.

"The patient is sensitive to the amount of pressure and draft upon his lungs, and can regulate both according to his own feelings. Fränkel leaves this regulation to the patient, but warns him against overexertion.

"The advantages of the apparatus are, that it is easily transportable and applicable anywhere (for inducing artificial respiration in cases of chloroform asphyxia, asphyxia of the new-born, poisoning by oxide of carbon, etc.). The apparatus is so cheap that the poorer patients can avail themselves of it and use it at home."

It appears to me that too much manual exertion is required from the patient in the use of this apparatus, and that one so contrived as to be worked by the foot, would be less laborious.

Hanke has invented two kinds of pneumatic cuirass to rarefy the air around the thorax, and thus effect its expansion in cases of insufficient inspiration, atelectasis, capillary bronchitis, and deformities due to collapse of the lung,* a result which his physiological experiments appear to promise. As yet there have been no results of the therapeutic application of the pneumatic cuirass published.

* Wien. med.-Presse, 1874, 34 and 36; Centralblatt für die med. Wiss., 1874, 58; London Medical Record, Jan. 20th, 1875, p. 38.

Nearly ten years ago, acting on the hint that "insufflation of the lungs, by means of a pair of bellows, is said to have been of advantage in asthma,"* I made the attempt to administer inspirations of condensed air, first by means of a pair of kitchen bellows, and subsequently by means of a tube leading from a large reservoir, in which air was compressed by a condensing syringe, in fact by the large condenser used in my office in the production of sprays for medical purposes. Five minutes' pumping will provide sufficient compressed air for half an hour's use; but the pressure is inconstant, and it is difficult to keep it uniform, even by continuous pumping; and after a few trials I abandoned the attempt. Subsequently I endeavored to employ a large acoustic bellows for the same purpose, but was unsuccessful in its use. Probably the want of sufficient data, of hospital material for experiment, and an indisposition to submit patients in private practice to treatment with which I was not familiar, deterred me from prosecuting experiments which might have eventuated successfully. The recent publications of Waldenburg and others have induced me to study the subject anew, and secure one of Waldenburg's apparatuses, in the hope, ere long, of acquiring some systematic personal knowledge in this interesting department of therapeutics.

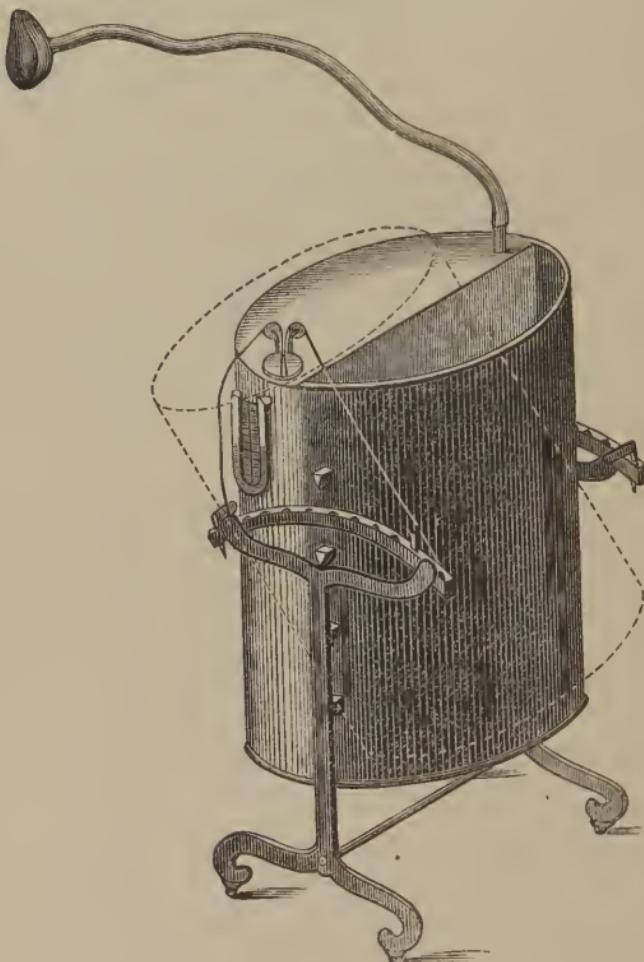
In the apparatus thus far described, the respirations of compressed or rarefied air are discontinuous or intermittent. Attempts have been made to provide for rhythmic or normal inspiration of these airs, but they have not, thus far, been successful. A certain approach, however, seems to have been made by Prof. Stoerek, of Vienna, who has constructed an apparatus on a different principle† of compression. Instead of using direct pressure for the purpose of condensing the air, he employs a change of level in the water contained in two communicating reservoirs, by altering their position as they are swung backwards or forwards. A tin vessel is separated into

* Wood's Practice, Philadelphia, 1858, p. 887.

† Ein neuer Athmungs-Apparat, Wien, 1874. Separatabdruck aus der Wiener medizinischen Wochenschrift, Jahrgang, 1874. See also Nos. 5, 20, 24, 39, 40.

two halves by a partition, with a slit for communication in its lower portion. The one side, the water reservoir, is open; the other side, the air reservoir, is closed, save by an opening communicating by a tube to the face or mouth-piece; and is further provided with a valve, to

FIG. 14.



Stoerck's Apparatus for Inhalation of Compressed and Rarefied Air
(from Stoerck).

permit the entrance of fresh air or the escape of the contained air. The apparatus is hung by prism-shaped

supports upon an iron frame, in such manner as to swing easily back and forth when pushed by the hand; the extent of swing, and thus the amount of pressure, being increased or diminished by raising or lowering the vessel, which is provided with a series of prisms at different heights. The vessel being half filled with water is ready for use. When swung in such a manner that the air reservoir is lowermost, water enters into the latter from the water reservoir, and thus compresses the air which escapes through the tube connected with the mouth-piece; and when swung in the reverse direction the water leaves the air reservoir, thus rarefying its contents. The movements of the vessel can be regulated to correspond with the acts of respiration, and thus the inspiration of compressed air may be immediately followed by expiration into rarefied air when the case requires it.

Metallic apparatus, being more readily cleansed, are preferable, because expiration into these contrivances, even from healthy lungs, cannot fail to contaminate the interior of any apparatus, and eventually render it injurious.

Treutler, of Blasewitz, has constructed an apparatus on the same principle.* It consists of two vessels communicating by a tube, one of which is placed above the other. If now, water be allowed to flow from the upper reservoir into the lower one, the air in the former is rarefied, and that in the lower one is condensed; and by reversing the position of the reservoirs, the air becomes reciprocally condensed and rarefied in the same manner, and so on *ad infinitum*. The same principle of hydrostatic pressure was employed by Dr. Arnold, of Rox-

* Wiener med. Woch, No. 33, 1874; Waldenburg, op. cit. p. 183.

bury,* for producing a current of compressed air with which to operate the Bergson nebulizing apparatus. A number of other apparatus have been devised, but they are hardly worthy of separate mention. The interested reader is referred to the work of Waldenburg, already cited.

Inpiration of compressed air increases the pressure on the lungs, and thus augments the vital capacity; the chest becoming expanded to a greater extent than can be accomplished by the most powerful voluntary inspiration of normal air. As a matter of course there is a consequent pressure exerted on all the organs in contact with the lungs, and on all the contents of the thorax. The action of the heart is increased and the pressure in the arteries augmented, so that the arterial walls are distended and the pulse becomes full and hard. The afflux of venous blood to the right auricle is impeded, and the blood accumulates in the arterial system, the pulse becoming lowered in frequency a few (4-10) beats in the minute.

Expiration into compressed air diminishes the quantity of expired air in proportion to the density of the compressed air. The interchange of gases is impeded, and if pushed to excess it will induce apnoea. It will strengthen the power of the auxilliary muscles of expiration. The effect on the circulation is similar to that of the inspiration of compressed air, but in a greater proportionate degree.

Inpiration of rarefied air diminishes the actual amount of air inspired, and if pushed to excess renders inspiration difficult, and produces apnoea. It strengthens the auxilliary muscles of inspiration. Its action in the circulation is just the opposite of the effect of inspiration of

* Boston Med. and Surg. Jour., Dec. 27th, 1866, p. 434.

condensed air. The intrathoracic pressure is diminished, and its physical influence is exerted upon all the organs within the thorax. The heart's action is impeded and weakened, and the pressure in the arterial system diminished; the pulse becomes soft, thin, compressible, and more frequent. The afflux of venous blood to the right auricle is facilitated, and blood accumulates in the pulmonary circulation, and diminishes in the general circulation. Pushed to excess, it may induce haemoptysis.

Expiration into rarefied air increases the amount of air expelled from the lungs, and the lung contracts to a greater degree than it does under the most powerful effort of normal expiration. A greater proportion of carbonic acid gas is therefore given off, and the succeeding inspiration is the more powerful and effective. It thus tends to decrease the volume of emphysematous lungs, and to increase the vital capacity of the lungs. The respiratory power is increased in both its acts. It affects the circulatory apparatus similarly to the inspiration of rarefied air, but in a much less degree. The pressure is diminished in the arterial system, and the pulse becomes soft, compressible, small, and more frequent. Blood accumulates in the intrathoracic organs, and diminishes in the remaining portions of the body.

It is thus apparent that in compressed and rarefied air we have powerful means of physically impressing the respiratory and circulatory systems, and thus of acting therapeutically upon them in diseases in which their functions are abnormally executed.

Inpiration of compressed air is indicated in dyspnoea of almost every origin, in the chronic stages of pleurisy and emphysema, in atelectasis, in certain conditions of consumption, in bronchitis, asthma, emphysema, inflammatory stenosis of the air-passages, asphyxia, insuffi-

ciency of the mitral valve, and in stenosis and insufficiency of the aortic valves.

Expiration into rarefied air is chiefly indicated in emphysema and bronchitis.

Inpiration of rarefied air is indicated in cases of contracted thorax, as in predisposition to phthisis and its earlier stages, and in convalescence after pleurisy.

Expiration into compressed air is indicated in cases of deficient normal expiration as a means of strengthening the expiratory muscles.

The employment of compressed air is contraindicated in cases where the pressure in the aortic system is already great, and in cases of congestion or disposition to it in important organs outside of the thorax, in atheromatous degeneration of the arterial walls, in patients of apoplectic build, in haematemesis, in menorrhagia, in bleeding haemorrhoids, and the like. Rarefied air is contraindicated in cases in which increased afflux of blood to the lungs is to be avoided, and in cases where the pressure in the aortic system is much diminished; as in haemoptysis and active inflammation of the pulmonary parenchyma, and in weak heart.

It has been proposed to localize the influence of condensed air upon certain portions of the chest, when desirable, as upon the upper lobes of the lungs, for example, in incipient phthisis. For this purpose the lower portion of the chest is to be encircled with a bandage to prevent its expansion during the inhalation of the compressed air.* If it is desired to confine the action to one lung, as in cases of pleuritic effusion, the patient is to lie upon the sound side so as to favor the entrance of the compressed air into the other side.† To localize the action

* Waldenburg, op. cit., p. 345

† (von Cube, Berlin. klin. Woch., 1874, No. 12), ibid.

upon the heart and the great vessels, the entire thorax is to be bandaged,* and so on.

Deep inspirations, long held, will reduce the pressure in the aortic system ; and this can be increased by closing the mouth and nostrils during the process (Müller's experiment). This may be employed as a partial substitute for the inspiration of rarefied air. Expiration with closed mouth and nostrils increases the pressure upon the circulatory apparatus (Valsalva's experiment) ; and this can be increased by external pressure upon the chest and abdomen (Weber's experiment). This may be employed as a partial substitute for inspiration of condensed air. Expiration assisted by external compression upon the chest and abdomen (Gerhardt's method),† may be employed as a partial substitute for expiration into rarefied air.

The above hints are thrown out by Waldenburg, for utilization in cases in which there is an indication for their employment, in the absence of pneumatic apparatus.

In this connection it may be remarked that forced respiration into the palm of the (left) hand, while the entire body is closely enveloped in a blanket, is an Indian method of warding off influenza, tonsillitis, and the like.‡

OXYGEN.

Dr. Priestley, the discoverer of oxygen, suggested its use as a therapeutic agent;§ but though utilized in that

* (von Cube, Berlin. klin. Woch., 1874, No. 12), ibid., p. 345.

† Waldenburg, op. cit., p. 349.

‡ George Catlin; Med. Times and Gaz., August 14th, 1869, p. 210.

§ Experiments and Observations on Different Kinds of Air (London, 1774). Birmingham, 1790.

manner by Cailleus in 1783,* by Jurine in 1784,† Chaussier in 1785,‡ Chaptal in 1789,§ and others, Beddoes appears to have been the first|| to have made any sustained systematic attempt towards its therapeutic employment.

Although occasionally employed for remedial purposes, oxygen did not attract much favorable attention from the profession until some years after the publication of Dr. Bireh's volume, in 1857,¶ in which the author claims the merit of "drawing professional attention to a much neglected but highly important subject in therapeutics."

Indeed, the rigorous investigations of Foureroy,— who stated that in a number of cases of phthisis which he treated by oxygen, although the earlier symptoms were palliative, so much so in some instances as to promise approaching recovery, violent evidences of inflammation ensued after a few weeks, apparently precipitating the fatal termination,**—tended to deter others from its employment. Even Dr. Beddoes found it,†† in

* (*Gaz. de santé*, 1783); Demarquay, *Essai de pneumatalogie médicale*, Paris, 1866, p. 577.

† (*Mémoires de la soc. de méd.*, 1789, t. x), *ibid.*

‡ *Ibid.* § *Ibid.*, p. 578.

|| *Observations on the Nature and Cure of Caleulus, Sea Scurvy, etc.* Bristol, 1792; London, 1793.

Considerations on the Medicinal Use, and on the Production of Faetitious Airs. Bristol, 1794, 1795, 1796.

¶ S. B. Bireh, M.D., *on the Action, Use, and Value of Oxygen in the Treatment of Various Diseases, etc.* Second edition, London, 1868, preface.

** *Annales de chimie*, 1790, No. 4; Deniarquay, op. cit., p. 597.

†† *Louis on Phthisis*, Cowan's Translation, Washington, 1836, p. 288.

his own person, to occasion true hectic, emaciation, dry cough, and dyspnœa.

Foureroy, however, "had witnessed good effects from inhalations of oxygen in the chlorosis of young girls, in the serofulous affections of children, in humid and chronic asthma, in abdominal obstructions, in hypochondria, in commencing rachitis, and in those obstinate dyspepsias accompanied by pallor of the skin and general debility. Its advantageous effects, in these affections, are manifested by very manifest augmentation of the heat of the skin, the appearance of color in the face, and acceleration of the pulse; these symptoms increasing, so that at the end of some weeks a veritable febrile movement results, and a general augmentation in the activity of the solids, the influence of which in the cure of chronic affections is no longer a problem for physicians accustomed to meditate on the march of nature in the spontaneous cure of many of these maladies."*

The most interesting and exhaustive account of the therapeutic uses of this agent is from the pen of Demarquay,† who presents a detailed study of its medical history, its physiologic action, and its therapeutic applications in the practice of medicine and of surgery. In opposing the views of those who believe the inhalation of oxygen to be dangerous, on account of its activity in chemical combustion, Demarquay states‡ that he himself, his friends, his pupils, and large numbers of his patients have inhaled from ten to thirty litres§ of the gas at a time without experiencing the slightest injury. With certain exceptions and variations dependent upon the

* Demarquay, op. cit., p. 599.

† *Essai de pneumatologie médicale*, Paris, 1866, pp. 554-822.

‡ Op. cit., p. 668. § A litre equals 1.0567 quarts.

idiosyncrasy of the subject or his state of health, the first inhalations of oxygen, writes Demarquay, produce sometimes a slight sensation of heat in the mouth, which is propagated to the larynx and the interior of the chest. This heat is rapidly communicated to the hypogastrium, but generally disappears a few moments after the inhalation of oxygen has ceased. The pulse is usually accelerated at the same time, and may increase from four to twenty pulsations, and even more, in the minute. The pulse also becomes hard, but this phenomenon is not of long duration. In some cases the pulse remains normal, or is even slightly retarded; but the most common phenomenon is the hardness it acquires. Many persons experience a sense of heat in the skin, and a disposition to moisture. The effect on the various sensations is but slightly marked, except in nervous subjects. In many instances a desire for muscular activity is developed.

The appetite is generally excited by these inhalations. Most of the patients to whom Demarquay administered oxygen experienced this result within a few days. He was unable to determine anything positive with regard to the other functions of the economy, especially as regards the secretions.

Some experiments performed upon himself by Dr. Andrew H. Smith, of New York,* developed the remarkable fact that the inhalation of a considerable quantity (400 to 1200 cubic inches) is followed by a temporary decrease in the amount of carbonic acid exhaled; but, notwithstanding this temporary decrease, Dr. Smith is of the opinion that the ultimate effect of oxygen is to cause its slight increase. Experiments of Dr. Smith as

* Oxygen Gas as a Remedy in Disease, New York, 1870, p. 22.

to the effect of oxygen on the excretion of urea indicate that it causes a decrease in the amount of urea formed. The quantity of uric acid in the urine appears to be rapidly diminished by the daily use of oxygen.* Kollmann† and Eckard conclude from this fact that oxygen may be administered as a remedy in acute gout.

Demarquay refers much of the objectionable results, formerly attributed to inhalations of oxygen, to certain impurities with which it became contaminated in the methods of preparation; an objection to its use which no longer exists under the improved methods of obtaining the gas in its pure state, for details of which the reader is referred to the standard works on chemistry.

Oxygen is indicated in anaemia and many of the affections with which it is associated, such as chlorosis and dyspepsia. Asthma is the affection for which it is most frequently prescribed. It often terminates the paroxysm, though it does not cure the disease. In acute phthisis with fever, it is contraindicated on the ground that superexcitation of the nervous or circulatory system is injurious. But in the earlier stages, associated with dyspepsia and impaired appetite, its effects are beneficial. It has been of service, also, in dilatation of the bronchi, in chlorosis, and in many cases of cephalalgia. These are the views of Demarquay, who presents them in detail, supported by the recital of many cases.

Among others he cites a remarkable case of ganglionary enlargements of the axilla, the neck, along the trachea, and probably along the bronchi, which had been sent to him with a view to tracheotomy, and in which, under the influence of oxygen, the condition

* Smith, op. cit., p. 24.

† Münchener Ärztl. Int.-Bl., 1869; Waldenburg, op. cit., p. 697.

underwent prompt amelioration, so that the operation became unnecessary, and the patient was able to resume her usual avocation.

He also thinks it will be found of service in typhoid and intermittent fevers, and in neuralgia, paralysis, and other affections of the nervous system.

Demarquay, as the result of his extensive clinical experience, recommends inhalations of oxygen in all chronic affections associated with debility, dyspepsia, and anaemia; the enumeration of which it is needless to repeat. In most of this experience, however, oxygen was not administered as the direct curative agent, but as part of systematic treatment, for its use in surcharging the tissues with oxygen, and facilitating the combustion of the elements of excretion. On this same general principle Demarquay was led to employ inhalations of oxygen in the treatment of surgical affections.* Both in the preparation of debilitated patients to undergo serious operations, and in the treatment of protracted suppuration and other depressing conditions after operation, inhalations of oxygen were found of great efficacy. A number of cases in point, of the most varying character, are detailed in the Medical Pneumatology of Demarquay.

It has been maintained by Lange, Pravaz, Demarquay,† and others, that the beneficial effects of compressed air-baths are due to the greater supply of oxygen which is presented to the body for absorption. In many respects the sensation experienced under the two conditions are analogous; but it is evident, upon reflection,

* The local application of oxygen to wounds, etc., does not come under our theme; and for details on this subject, the reader is referred to the essay of Demarquay, so often cited, and to other essays on oxygen gas.

† Op. cit., pp. 673-680.

that the free access of a gas to the part cannot exercise that physical influence of compression or condensation to which so much of the benefit of compressed air is attributable. There may be a similarity, doubtless, in the chemical effects upon the blood of compressed air and of oxygen, even though their action be not identical ; and the secondary results of these effects may then, of course, be the same in either instance. The physical impression upon the respiratory surfaces, however, is different, and in so far as the physical influence for compressed air is indicated as a restorative measure, facilitating the resumption of impaired function, it is not fulfilled by the simple inhalation of free or combined oxygen.

The inhalation of oxygen in the narcosis from chloroform, carbonic acid, opium, and the like has received commendation from several reliable sources.

Thus, under the impression that the specific effects of ether vapor upon the system are due to its power of producing a state analagous to asphyxia, it has been suggested by Dr. Jackson, and subsequently by Mr. Richardson,* that oxygen should be kept ready to be inhaled in case of the occurrence of formidable symptoms ; and Mr. Hooper, acting on the suggestion, has supplied his inhaler with the means of furnishing oxygen at pleasure. "Ducroy has stated in the Parisian Academy of Science,† that pure oxygen, contrary to the general belief, can be inhaled for several hours without being detrimental to health ; that its action is antagonistic to that of chloroform ; that it is a powerful remedy for the disagreeable accidents arising from chloroform and other anaesthetics ;

* Ranking's Abstract, vol. 5, 1847, p. 332.

† June, 1850 ; Arch. gén. ; also, Beigel on Inhalation, London, 1866, p. 72.

and that in asphyxia from poisonous gases—as, for instance, from carbonic acid—it exercises likewise a beneficial influence. Dueroy, therefore, proposed to make every patient, awaking from a chloroform-narcosis, inhale oxygen, in order to rid him of headache and other inconveniences following the administration of that anaesthetic. According to the reports of different authors, it should be a rule, whenever chloroform is administered to have the oxygen-inhaler ready for use."

Mr. Erichsen, in his *Monograph on Asphyxia* says: "In a considerable number of experiments that I have performed on this subject, I have never succeeded in re-exciting the contractions of the ventricles by means of the inflation of the lungs with common air, provided they had fairly ceased to act before artificial respiration was set up." He was then led to try oxygen, and in several instances was successful in restoring the action of the ventricles after the entire cessation of the heart's action.*

The following case is related† in support of the idea that the inhalation of oxygen might be very beneficial in the asphyxia caused by chloroform and carbonic acid, or by drowning :

"A young man attached to the laboratory of the New York Medical College," writes the late Dr. Simeon Abrahams, "became asphyxiated from the inhalation of the vapor of chloroform; and so far had its effects been carried, that he became pulseless, and all hopes of his resuscitation abandoned; and as all the usually recommended remedies had been tried without success, nothing but the death of the young man was looked for, when I proposed, as a *dernier ressort*, the application of pure oxygen gas as the only

* Beigel op. cit., p. 73.

† Ranking's Abstract, vol. 17, p. 118, from the Canada Medical Journal, Jan. 1853.

chance by which resuscitation could be brought about; but, at the time, the proposal met with opposition from the medical men present, who were anxiously watching what seemed to be the expiring efforts of the poor boy, expecting each moment to be his last. Having, however, consented, the gas had not been more than a few seconds applied to his nostrils, when he who was apparently beyond the help of human aid, and absolutely *in articulo mortis*, arose and placed himself upon a chair, proving most conclusively how correct I was in proposing the application of oxygen gas as a remedy against the deleterious effects of chloroform as an anaesthetic."

Dr. Const. Paul,* reports a case in which the gas was successfully used in a case of opium poisoning, after atropia had failed, and when the patient appeared to be dying; and another, in which it was successfully employed in narcosis from charcoal gas.

Two cases of restoration by oxygen in poisoning by carbon are reported by Sieveking,[†] and one, a curious case, by Linas.[‡]

Inhalation of oxygen has been employed with more or less success in cholera. Thus it was used with success by De Smyttere, in the epidemic of 1832 ;§ and in the *Reports on Asiatic Cholera in the Madras Army from 1828 to 1844*,|| it is spoken of favorably. So, also, favorable cases have been reported by Maerae, in India, in 1850, and Harvey, in London, in 1853 ;¶ while Schwarz, in 1831, ** Foy, in Poland, 1831, and Hutin, in

* Bull. gén. théér., t. lxxv, Aug. 15th, 1868; Allg. med. Cent. Ztg., 1868, p. 939; Ranking's Abstract xlviii, 1869, p. 117.

† The Lancet, 1869.

[‡] Bull. de thérap., June, 1869, p. 519; Gas. méd., Paris, 1869, No. 18, p. 245.

² Smith, op. cit., p. 32

By Samuel Rodgers, London, 1848.

[¶] Smith, op. cit.

** Waldenburg, op. cit., p. 696.

Africa, 1835,* employed oxygen without any beneficial results.

Coming more closely to the present decade we find that Dr. Wittmeyer,† of Nordhäuser, has suggested the inhalation of oxygen, and of the vapor of water in the stage of asphyxia in cholera. He is led to the employment of these inhalations because the functional activity and absorbent powers of the alimentary canal being impaired, and hypodermic injection having failed, there remains open to us but the respiratory tract by which to convey remedies to the system at large. He considers two indications highly important in this stage of cholera ; the first being to convey water to the thickened blood ; for which purpose he proposes that the patient shall inhale steam and hot water nebulized from one of Seigle's apparatus, the temperature of the nebulized water being kept sufficiently warm by a flame under the medicine-glass ; then, he contends that as the thickening of the blood impedes the interchange of the gases in the lungs, the second indication is to convey oxygen to the blood, which is best accomplished by inhalation of the pure gas, which he maintains would have a more promptly excitant action upon the heart than any ordinary medicine which could be administered in another method ; and as a result, the blood would be enabled to circulate through the vessels more rapidly, and become better and better prepared to imbibe the desired amount of vapor of water and of oxygen.

Dr. Jütte, of Stettin, commenting‡ on the article of Dr. Wittmeyer, says that he had made the experiment

* Smith, op. cit.

† Deutsche Klinik, Oct. 13th, 1866, p. 366.

‡ Ibid, Dec. 1st, 1866, p. 436.

of administering oxygen by inhalation to four adult patients during the short and severe epidemic which prevailed in and about Stettin in the year 1856; and that the administration had been conducted with great care, and with sufficient frequency; but that all of his patients died without evincing the least sign of even temporary improvement, and he was so disappointed with the result that he did not pursue the experiment any further.

This idea of Dr. Wittmeyer is not new, as far as regards oxygen inhalations in cholera; though, as far as I know, the suggestion of the inhalation of the vapor of water under such circumstances, is entirely original.

As early as 1794, oxygen had been employed in croup;* and Bretonneau reported to the Parisian Academy of Medicine, in 1821, good effects in a case of croup in which it was sought to prolong life by means of oxygen until calomel could have time to act; and although it failed, he was of the opinion that it might have been of more avail under more favorable circumstances.†

Beigel‡ considers the administration of the gas indicated in the suffocative paroxysms of croup to guard the patient from the consequences of such attacks, which frequently prove fatal, and to place him in such a position as to enable us to apply other remedies; oxygen, under such circumstances, having in some measure the same effect as tracheotomy, whereby we intend to evade a particular part of the respiratory tract, in order to gain

* Baillie, Med.-Chir. Trans., 1815, p. 136.

† Second Memoir, Sydenham Society's Memoirs on Diphtheria, London, 1859, p. 51.

‡ Op. cit., p. 104.

time till we possibly master the inflammation, as well as the formation of the pathological products represented by the croupal membranes.

As an illustration of this fact, Dr. Beigel reproduces the following case, reported by Miquel :*

"Severe case of croup; application of the usual medicaments without benefit. Immediate alleviation after oxygen had been inhaled.—The patient was a boy twenty-one months old, hitherto perfectly healthy. On February 21st, 1862, Miquel was summoned, and found the child in the following condition: Breathing, noisy and whistling, short, some fifty respirations in the minute, but irregular, as well in respect to the rhythm as to duration; pulse small, very frequent, impossible to be counted; countenance pale, lips livid; all muscles are active during breathing, and the regular movements of the levatores alae nasi, of the muscles of the throat, etc., were combined with irregular spasmodic movements, which now and then agitated the face. The little patient frequently bent his head quite backwards, the expression of his countenance being very anxious, and seized his throat convulsively with his hands. His face was moist and cold. The child very seldom yet made efforts to cough; when coughing, the voice appeared barking, hoarse, suppressed. According to the report of the house doctor, nine days ago the child was seized with symptoms of croup, which at first decreased by emetics, leeches, and other remedies, but three days ago have recurred with great intensity. The usual remedies were applied again, but failed to do any good, and a newly administered emetic was to the same effect; involution of the legs in mustard powder, and inhalations of hot steam, were vainly resorted to. At half-past ten, inhalations of oxygen were tried. One cubic foot of that gas, one volume of pure oxygen mixed with a smaller portion of atmospheric air in a gasometer, was brought to the patient's residence. The amount of respiration might have been about five cubic inches, the quantity of gas (1728 cubic inches) was, therefore, sufficient for 350 inspirations, which might have been performed in about nine or ten minutes, yet the procedure lasted about fifteen to twenty minutes. The child's

* Correspondence-Blatt des Vereins für gemeinschaftliche Arbeiter, 1862.

condition after the inhalation was the following: pulse perceptible, less frequent, number of respirations about the same. The appearance of the child was, according to the judgment of all persons around him, more quiet, less anxious; patient became more reactive to the impediment to respiration, so that he coughs frequently, though with the peculiar croup sound; once such a cough spontaneously produced vomiting. The spasmodic movements of the muscles of the face, as well as of other regions of the body, ceased, and at one o'clock in the morning the parents came to me to report that the child had slept very quietly, and that the spasm and anxiety had disappeared. They added that on no previous night the suffocating seizures and the expression of the countenance were so alarming; but that on none of the four previous nights was the patient so quiet as he is to-night. On the following morning the child was found to be still better, and though the oppression recurred on the following evening in a slight degree, yet all the remainder vanished by medicaments applied for the disease itself, and the patient recovered entirely."

Beigel relates the details of several cases under his own care, treated by alternate inhalations of oxygen and of nebulized fluids.

One of these* was advanced diphtheria in a child six years of age, which was cured by the inhalation of oxygen gas, one gallon morning and evening, and the inhalation of a solution of the tincture of the chloride of iron, ten minims to the fluid ounce of water; a remarkable alteration in the patient's condition being perceptible after the first inhalation of oxygen. Also† a very severe case of diphtheria after small-pox, with exudation lining the whole pharynx, laryngeal implication, suffocative paroxysms, etc. The patient, a boy ten years of age, was seen by Dr Beigel on the fourteenth day of the illness, after the administration of ealomel for six days had afforded no relief. This case was treated by inhalations of the spray of hot water, afterwards of lime-water, and subsequently of tannin; oxygen being administered to relieve the suffocative attack with complete success, and being continued twice a day as long as requisite; the combined treatment resulting in a cure.

* Op. cit., p. 114.

† Op. cit., p. 116.

Dr. Andrew H. Smith* states it as his "firm conviction that oxygen will do in croup all that can be done by tracheotomy," though "neither the one nor the other is competent to undo the mischief wrought by severe and prostrated dyspnoea." It is hardly necessary to say that this opinion is not indorsed. The author has elsewhere† expressed the opinion that in croup atmospheric air is wanted and not oxygen, and that if the glottis be too obstructed to admit of a proper supply, a larger aperture should be made artificially for the purpose, for oxygen cannot be a substitute for tracheotomy as long as the calibre of the glottis is diminished by swelling or false membrane. Still it must be borne in mind that some experiments instituted and described by Dr. B. W. Richardson, of London,‡ led him to the belief that the retention of carbonic acid gas favored the fibrination of the exudation; so that oxygen may possibly counteract the effect of the carbonic acid gas, and keep the exudation diffuent. So many cases in which tracheotomy is indicated, terminate favorably without it, that it is impossible to place a correct estimate upon the value of any legitimate remedy, the administration of which is followed by recovery.

Beigel believes that in children predisposed to phthisis, the inhalation of oxygen gas would delay, or even prevent the outbreak of the disease; and that even after the development of the affection, inhalations of oxygen gas sometimes render astonishing services.

In proof of this he details a case§ in which an engineer, twenty-

* Op. cit., p. 28.

† Diseases of the Throat, New York, 1872, p. 405.

‡ The Lancet, Sept. 24th, 1870, p. 438.

§ Op. cit., p. 182.

three years of age, of serofulous diathesis, with tuberculous infiltration of the left apex, and bronchial catarrh of the right lung, with haemoptysis, colliquative perspirations, and rapid loss of flesh, was so much improved by the inhalation of a gallon of oxygen twice a day, and of a solution of the sesquichloride of iron twice a day, that in a little less than five months, at which time the treatment was discontinued, the patient could hardly be recognized as the same man; he had grown strong and muscular, and but that dulness remained at the left apex, he could be considered perfectly healthy. He was seen a year afterwards by Dr. Beigel, whom he assured that he had enjoyed very good health during the whole of that period.

My personal experience with oxygen gas as a therapeutic agent has been comparatively limited, chiefly because I have not found it as valuable an agent in my own hands as it appears to have been in the hands of others. I have employed oxygen in a number of cases of imperfect aeration of the air-cells of the lungs from deficient inspiration, and with decided benefit; but I am not prepared to state the benefit was not entirely due,—as it was in great measure due, certainly,—to the mechanical effect of the inhalation expanding the air-cells by forced inspiration; for in the fine weather of spring and summer I have seen results fully as satisfactory from regular deep inspirations of fresh air: the patient seated in the open atmosphere, or before an open window, and taking deep inspirations slowly, while an attendant forces the shoulders backwards so as to assist the expansion of the chest during the effort of inspiration. From four to eight such efforts are sufficient at a time to begin with, and may be repeated twice a day. In cases where there is a sense of oppression in the upper portions of the chest from inefficient expansion, the relief given by these movements is prompt and decisive.

I feel free to record that in one case of undoubted incipient

phthisis,—by which I mean a case of impaired respiration, in which the general symptoms and the family history strongly pointed to the onset of pulmonary tuberculosis, but in which there were as yet no positive physical signs of the disease other than impaired respiration, and extreme dyspnoea, at the first institution of the mechanical exercises above mentioned,—the inhalation of oxygen gas certainly warded off the threatened disease, and gave the patient renewed vigor, as evinced by increase in nutrition, renewal of vital buoyancy, and restored powers of physical endurance. Of course, it is impossible to say determinately that this case would have been one of phthisis; for when any threatened disease is early arrested, or aborted, the pathological evidences of correct diagnosis are lost. This patient, treated in 1866, remained in fair health for a number of years; but of his subsequent history I know nothing.

After faithfully trying oxygen in many cases of confirmed phthisis, I am not disposed to regard it with any special favor. In some of my cases it afforded considerable temporary relief to dyspnoea, but I do not really believe that life was prolonged in any instance by its agency. The idea of breathing a “purified air” is greedily entertained by patients who insist that “they would get right well, if they could only breathe better,” and in this way the occupation afforded to the mind for a few days actually effects an improvement in the general condition for the time, in some instances. The improvement, unfortunately, is transitory; and I can hardly recall a patient who did not soon become indifferent to the inhalation of oxygen, or in whose ease the oxygen was not abandoned, sooner or later, without any regrets, save for the disappointment. Still I have seen considerable comfort follow the institution of the treatment, whether emotional or physical I am unable to determine; and this sense of satisfaction sometimes remains until it is apparent that the oxygen is incompetent to cure the disease; and, therefore, oxygen may be legit-

mately resorted to upon suitable occasions. Despite the contempt expressed for the opinion, I believe that the prolonged use of oxygen burns the patient up, in some instances, or in other words, consumes him the faster; and this is the more evident if it is impracticable to supply by nutriment the waste of tissues subjected to super-oxygenation. There is a time, in tuberculous phthisis especially, when oxygen will no longer palliate, relieve, or stimulate; and the decline, as was recognized by Fourcroy, seems really more precipitate in consequence of the previous employment of this powerful agent for good or evil.

So much has been claimed, however, for the therapeutic uses of oxygen inhalations, that I have deemed it a duty to present a fair representation of the records in its favor.

Almost all writers on oxygen extol its use in anaemia, chlorosis, asthenia, asthma, emphysema, and the pretuberculous stage of phthisis. But it is said to have still further uses. Of its employment in cholera and in croup mention has already been made. It has also been used in diphtheria. Dr. Francis* used it with advantage in a case of malignant scarlatina with diphtheritic exudation in the throat, and believed it to have assisted in sustaining life during the remedial action of other agents. It has been used with more or less success in the treatment of many constitutional diseases; diabetes,†

* *The Lancet*, March, 1858.

† Birch, *Brit. Med. Jour.*, December 24th and 31st, 1859, and op. cit., p. 105; Bouchardat (*Rev. méd.*, 1857), *Arch. f. klin. Med.*, 1870, p. 51; (Berénger-Fraud and Yvan), Demarquay, op. cit., p. 710.

albuminuria,* syphilis,† serofula,‡ scorbutus,§ gout,|| boils and carbuncles,¶ torpid and gangrenous ulcers,** neuralgias,†† epilepsy,††† paralysis,§§ atonic and fatty diseases of the heart,¶¶¶ dyspepsia in valvular cardiac disease,¶¶ and also in pneumonia,*** capillary bronchitis,††† and some other acute affections.

The gas is occasionally administered pure, but more frequently mingled with from one to ten or more parts of atmospheric air, and to the amount of from one to ten gallons once or twice a day. The atmosphere may be roughly impregnated with oxygen extemporaneously by throwing a quantity of chlorate of potassa upon live coals, but of course this method is much inferior to one by which the gas can be collected in a reservoir. Oxygen may be inhaled from a simple reservoir, gasometer, or gas-bag, or from cylinders into which it has been compressed. The latter is the preferable plan; and it is advisable, as recommended by Demarquay, to allow the gas to pass through a wash-bottle before reaching the tube to which the mouth-piece is attached.

* Casorati (Gaz. Lombard, 1852, No. 19) Waldenburg, op. cit., p. 697; Prof. Mackey, Practitioner, May, 1869, p. 276; Smith, op. cit., p. 47.

† Birch, op. cit. ‡ Beddoes. § Ibidem.

|| (Kollman and Eckardt) Waldenburg, op. cit., p. 698; Golden, the Lancet, March 10th, 1866.

¶ Birch, op. cit., p. 74. ** Hill; Thornton; Demarquay.

†† Hooper; Birch; Demarquay.

††† Beddoes; Birch; Ramskill, Med. Times and Gazette, July, 1863.

§§ Beddoes; Birch; Tannin-Despalie (Gaz. méd., Paris, 1875, p. 229); Practitioner, July, 1875, p. 60.

¶¶ Birch. ¶¶ Smith, op. cit., p. 31.

*** Golden, Lancet, March 10th, 1866; Smith, op. cit., p. 29; George H. Butler, New York Med. Jour., November, 1869, p. 149.

††† Smith, op. cit., p. 30.

OZONE.

Inhalations of ozone have been recommended in cholera by Stiemer,* and by Seelles in diabetes and gout.† The principal advocate of ozone is Lender,‡ who not only recommends it in all cases in which oxygen is indicated, but also in the entire series of septic diseases, in the list of which he includes many affections that are not at all regarded as infections; so that, as Waldenburg remarks, the entire subject has been more injured than benefited by the great extent of his researches.

Ozonie ether has been administered by inhalation in phthisis; and this method has been considered preferable to its administration by the stomach.

Lender proposed its inhalation from the so-called ozonized water, introduced into a Wolfe's bottle or ordinary inhaler; but it is a matter of doubt among chemists whether this water contains any ozone at all.

Ozone for inhalation is, perhaps, best prepared by the action of strong sulphuric acid on the bichromate or the permanganate of potassa. Böttger§ mixed very gradually three parts of the acid with two of the latter salt, and he states that this mixture will continue to give off ozone for several months. It has been prepared in various ways for chemical and physiological experiment,

* (Die Cholera, etc., Königsberg, 1858); Waldenburg, op. cit., p. 709.

† (Acad. de méd. de Paris, June 27th, 1875), *ibid.*

‡ (Sauerstoff und Ozon-sauerstoff, Berlin, 1870; various articles in the *Berliner klinische Wochenschrift* for 1871, and in the *Deutsche Klinik* for 1870, 1871, and 1872), *ibidem*, p. 708.

§ (Zeitsehr. f. Chem. und Pharm., Bd. iii, p. 718); Fox, Ozone and Antozone, London, 1873, p. 25.

for an account of which the reader is referred to the work of Dr. Fox.

NITROUS-OXIDE.

The inhalation of nitrous-oxide (laughing-gas) has been employed pure, for the purpose of supplying the system with a large amount of the oxygen it contains, and in the same affections for which oxygen has been recommended, such as anaemia, incipient phthisis, and the like. It is now prepared extensively in all our large cities as an anaesthetic for dental purposes, and can thus be readily procured by those who wish to try its efficacy.

Beddoes employed it with benefit in paralysis,* and Sir Humphrey Davy† inhaled it three times a day for periods of one week and two months respectively, and found it of great benefit to his general health. He experienced a surexcitation of all the organs of sense, as evinced by more distinct and lively sensations than were common.

Riadore‡ employed it with success in a number of cases, principally affections of the nervous system.

Surgeon George G. Shumman, United States Volunteers, has reported§ a number of cases (fourteen) of typhoid fever, also two of measles, and one of erysipelas, in which inhalations of the nitrous-oxide gas were administered at the stage of prostration for the purpose of supplying oxygen to the system, with beneficial results in all cases;

* Sir H. Davy, *Researches, etc.*, chiefly concerning Nitrous-oxide, 1800, p. 542.

† Op. cit.

‡ *On the Remedial Influence of Oxygen, Nitrous-oxide, etc.*, London, 1853.

§ Am. Med. Times, 1863, pp. 28 and 38.

even in some which proved fatal, for life had been apparently prolonged many hours by this means, although insufficient to stimulate to the point of recuperation. Some of these cases which recovered, had been pronounced hopeless, and all of the patients are reported as having expressed themselves as feeling much the better for the inhalations. Attention is called to the resort to this method in the prostrated stages of cholera and other affections.

Whether it acts by supplying oxygen is an open question. Other compounds of oxygen and nitrogen containing a much larger proportion of oxygen, are, as is well known, extremely deleterious when inhaled. It is quite probable that the nitrous-oxide has an influence of its own; because we know that the action of chemical compounds is often different to what might be inferred from a knowledge of the effects of their constituents.

Dr. C. W. Larison* has reported a case of recovery in miliary tuberculosis under inhalations of five gallons of the gas a day, at intervals.

NITROUS ACID.

Dr. Thomas records† a case of hooping-cough of nearly three weeks' duration, which was cured within ten days by the inhalation of nitrous gas:

The patient was his own son, aged between four and five months, and he was led to the use of the remedy from the perusal of some cases treated by this gas by Mr. Patterson, in J. Carmichael Smith's work on Nitrous Vapor, to which his attention was called for the purpose by a professional friend. He closed

* Cincinnati Med. News, November, 1874.

† Am. Med. Recorder, 1822, p. 660.

every aperture of the apartment occupied by the little patient, which might afford exit to the gas; he then placed a teacup in a sand-bath, poured half an ounce of sulphuric acid into the cup, to which he gradually added half an ounce of pulverized nitrate of potassa, so as to occupy an hour each night in the disengagement of the vapor. The application did not provoke cough, and the child usually fell asleep at an early hour. The treatment began on the night of July 30th, and after that of August 1st there was no more whooping, and in ten days the child was well. Dr. Thomas concludes thus: "In the foregoing case it appears evident to me, and I trust it will to all those who read it, that the vis medicatrix naturæ had no agency in relieving the patient. I am willing at all times to pay due homage to that power, but not at the expense of truth and justice; let us, therefore, 'render unto Cæsar that which belongs to Cæsar,' and not ascribe merit where none is due."

Dr. Nevins writes,* "Nitric, or rather, perhaps, nitrous acid, is sometimes used as a fumigation by simply pouring a small quantity of fuming nitric acid into a saucer upon the table near which the patient is sitting. In some cases of phthisis, and of chronic bronchitis, with excessive expectoration, the acid fumes, thus diluted with air and received into the lungs, have produced great relief by checking the secretion and improving the condition of the mucous membrane generally. It is quite under the patient's control, and may be used two or three times a day, according to circumstances and the relief produced."

HYDROGEN.

Hydrogen gas, mixed with common air, was employed by Beddoes in the treatment of some chronic affections of the respiratory organs, including phthisis, under the opinion that an air less rich in oxygen than common air

* The Prescriber's Complete Handbook, London, 1858, p. 123.

would produce narcotic effects. He found it to relieve pain and promote sleep in phthisis and in the inflammatory period of bronchitis. He administered it for a quarter of an hour in the proportion of one-eighth part, in a case of inflammation of the chest, and found it to relieve the severe pains and reduce the fever. A few other authors have reported similar results. Demarquay* quotes a case cited by Berzelius, in which a young phthisical girl, tormented with insomnia, was enabled to sleep peacefully after a quarter of an hour's inhalation of a mixture of four parts of hydrogen with one of oxygen, the effect being reproduced each time the experiment was repeated.

SULPHURETTED HYDROGEN.

The emanations of sulphuretted hydrogen from mineral springs have long been employed in Germany and in France, in the local treatment of various affections of the pulmonary organs, including non-febrile phthisis, catarrhs of the larynx, trachea, and bronchi, emphysema, asthma, hooping-cough, and catarrhs of the nasal passages, frontal sinuses, and pharynx.†

CARBONIC ACID.

Inhalations of carbonic acid gas were employed by Percival, in 1774, as a palliative in the latter stages of pulmonary phthisis.‡ Dobson,§ and other of his con-

* Op. cit., p. 854.

† Waldenburg, op. cit., pp. 725-728.

‡ Priestly, op. cit.

§ A Medical Commentary on Fixed Air. Chester, 1779, p. 51.

temporaries,* also recognized the good effects of the inhalation of carbonic acid gas in confirmed phthisis. With Beddoes, they resorted to it for the purpose of diminishing the amount of oxygen inspired into the lungs in diseased conditions, in which that gas was believed to be too stimulating; and they report beneficial anaesthetic and antiseptic influence from these inhalations. In Germany and elsewhere similar favorable results were reported, a few of them quite remarkable; more or less details of which are furnished by the authors cited.

The inhalation of the gas at the sources of mineral waters containing it in considerable quantities has also been tried with some success. Demarquay cites the experiments of Goin, at St. Albans, in 1834, of Nepple at the same resort, in 1846; and Waldenburg,† those of Spengler at Ems, in 1855, and others. Of late years these inhalations have been employed at various other Continental resorts also, in the treatment of phthisis, asthma, chronic and fetid coryza, and chronic inflammations of the air-passages. The gas is usually collected in a bell-glass or other apparatus, to which a flexible tube is attached, by means of which the gas is directed into the mouth. At Franzensbad a large basin has been constructed, at the bottom of which the gas is disengaged, the upper stratum of air containing fifteen per cent. As the patients become accustomed to the gas they descend lower into the basin, and thus nearer the orifice from which the gas escapes. Willemin, who

* Francis Home, Clinical Experiments, etc. Edinburgh, 1779. Simmons, Practical Observations on the Treatment of Consumption. London, 1779. Demarquay, op cit., p. 475.

† Op. cit., p. 720

gives some of the above details, and others,* considers that these inhalations are especially efficacious in chronic inflammations with atony of the mucous membrane, and exaggerated secretion, and in nervous affections of the respiratory organs; but that they ought to be avoided in phthisical cases.

Demarquay, whose researches on carbonic acid are no less interesting than those on oxygen, to which we have already had occasion to refer, after a number of preliminary experiments upon animals, experimented upon himself.† After inspiring twenty litres of a mixture of eighteen parts of oxygen and two of carbonic acid, he experienced a sensation of intense heat in the entire chest, but particularly at the middle of the epigastrium; a sensation which persisted for about a quarter of an hour. During the terminal inspirations his countenance became somewhat injected, and the respiratory movements became accelerated despite his desire to respire slowly. Vertigo ensued, preceded by slight cephalalgia, but it was slight and disappeared one or two minutes after the completion of the experiment, which occupied about four minutes. There was no appreciable change in the state of the pulse. Increasing the proportion of carbonic acid to one-fourth of that of oxygen, the gas, tasteless in the lesser proportion, acquired a special acid taste by no means disagreeable. At the end of a few inspirations there was a perception of great heat at the epigastrium, irradiating through the entire chest; and a special sensation, in some sort instinctive, that the air being respired was not suitable for his organism. This

* (Union méd., July 15th, 1858; Brit. and For. Med.-Chir. Rev., Jan. 1859); Am. Jour. Med. Sci., April, 1859, p. 544.

† Op. cit., p. 441.

sensation, more subjective than objective, evinced itself in an imperious desire to refill the apparently empty lungs, thus producing a forced acceleration of the respiratory movements. At the close of the experiment his face was very red, his eyes a little prominent, and respiration anxious and panting. Vertigo was more pronounced than in the first experiment, and of longer continuance; and the heat in the chest remained sensible for an hour afterwards. The pulse became increased at first from 76 to 84, which is a matter of no moment, as it may have been due to the acceleration in the respiration; but it afterwards became less strong and less perceptible. Some of Demarquay's pupils respired similar mixtures, with the same general results in different degrees, some of them being but little susceptible to its influence. A mixture of one part to three of oxygen was almost insupportable to himself, while it was readily supported by some of his pupils.

In 1866, Dr. James Collins, of Philadelphia, and myself, made some experiments in the inhalation of carbonic acid from reservoirs in which the gas had been forced under compression; chiefly, however, with a view as to the safety of its employment as a nebulizing agent in the production of sprays for inhalation, but our results were not recorded, and we have never repeated the experiments. Our conclusions were, however, that the admixture of gas with the spray was not attended with the danger we had anticipated. Dr. Collins inhaled the spray thus produced for half an hour continuously, without experiencing any unpleasant effects from the carbonic acid gas.

When an attempt is made to inhale the undiluted gas, a spasm of the glottis is provoked and the entrance of the gas excluded. In moderate dilution it is simply irrespirable; but in larger dilution than that supposed to be

noxious in common air, it may be inhaled for some minutes continuously, with little or no inconvenience, according to the idiosyncrasy of the individual. This, therefore, as remarked by Demarquay,* affords time enough to produce a therapeutic effect, if the use of the gas is indicated. Demarquay suggests† that the emanations from earth-baths, found useful in phthisis and other diseases, is due to the carbonic acid of which they are in great part composed.

Much of the benefit attributed by Beddoes and his contemporaries to residence in or near cow-stables, in cases of phthisis, is judged to have been due in part to the carbonic acid gas exhaled by the cattle.

Sir J. Simpson deemed inhalation of this gas beneficial in chronic bronchitis, asthma, and irritable cough.‡

CARBURETTED HYDROGEN.

The vapors of *illuminating gas*, carburetted hydrogen, have been successfully employed in the treatment of whooping-cough. Early in 1864, at Amsterdam, children with this affection were sent to the place of manufacture of the illuminating gas, and allowed to breathe the gaseous atmosphere for a certain period, with very satisfactory results, many cases having been considered to have been cured in this manner, and without injurious consequences in any one instance.

The same method was employed at Calais in the winter of 1864, during an epidemic of pertussis, a number of children thus affected being sent to the gas-house to breathe the vapor at the moment of escape after subjection to the purifying process. As soon as the children

* Op. cit., p. 459.

† Op. cit., p. 471.

‡ Ringer's Therapeutics, New York, 1875, p. 53.

breathed this air they began to improve, and thorough cures resulted. Two or three visits sufficed to put an end to the paroxysms of cough.

Other investigations were made in this direction about the same period. Thus, M. Commerge presented to the Imperial Academy of Medicine, a report* on this subject drawn up from the observation of the effects produced on one hundred and forty-two children affected with whooping-cough, who had been subjected to the action of the gases in the gas-works at St. Maudé. His conclusions are to the effect that the treatment produces excellent results, and at all periods of the disorder. In general, twelve séances are required for the cure, and each séance should be of two hours' duration. However young the patients, no danger results from the exposure to the gases. Then again, Dr. Bertholles informs the French Academy of Medicine of the effects observed to result from the inhalation of the vapors disengaged from the remains of the materials used in the purification of gas, by children having whooping-cough. The register of the coal-works at Ternes shows that during a series of six months, nine hundred and one patients had been subjected to this vapor treatment, and that of these, two hundred and nineteen were cured, and one hundred and twenty-two relieved. The favorable results are probably due to the ammoniaeal gases and the tar vapor associated with it.†

In this connection it will be interesting to record here the results of some experiments performed upon cases

* Am. Jour. Med. Sci., April, 1865, p 487, from Brit. Med. Jour., Nov. 5th, 1864.

† See more recently on the same subject, Schmidt's Jahrbücher, July, 1866, p. 63.

of whooping-cough, at the St. Annen Children's Hospital, of Vienna, with the view of determining the effect of the inhalation of various gases in the treatment of this affection.

These results are summed up as follows :

1st. Inhalation of pure oxygen gas did not, in any instance, produce paroxysms of cough.

2d. Inhalation of nitrous oxide gas, or of a mixture of oxygen and atmospheric air in equal parts, did not produce a single paroxysm of cough, even when the inhalation was continued for a considerable period. The children inhaled it with eagerness for from five to ten minutes, and would have continued to do so longer, had permission been allowed.

3d. Inhalation of pure nitrogen and hydrogen was attempted only on a single occasion ; the children breathed it very unwillingly, and only for a very short period. In two cases, the inhalation of nitrogen was interrupted by paroxysms of cough. Inhalation of hydrogen produced disposition to cough in one case.

4th. The inhalation of carbonic acid gas always produced a very heavy fit of coughing at the first deep inspiration, even when the experiment was continued for a very short time. An experiment was made with a mixture of one volume of carbonic acid gas with fifteen volumes of ordinary air, which always produced a fit of coughing, either immediately or within two or three minutes. With further dilution the result was not constant, but fits of coughing followed much more frequently than from the inhalation of pure atmospheric air.

5th. A very slight proportion of ammoniacal vapor, so slight that it could not be detected by the sense of smell, was followed by constant severe paroxysms of cough in the limited number of cases in which it was tried.

Dr. Hauke, in summing up the practical results of these experiments, and arguing from the fact that carbonic acid gas is the gas most obnoxious to whooping-cough, on the ground that there is some arrest of the separation of carbonic acid gas in the lungs, puts the following question : Does this arrest or hindrance to the separation of carbonic acid gas from the lungs of

children laboring under whooping-cough, throw any light upon the cause of the peculiar fits of coughing? His anatomical and clinical experience assures him that such is the case; and although his investigations have not furnished any specific remedy against whooping-cough, some valuable assistance has been gained in decreasing the number and severity of the paroxysms of cough.

These investigations appear to substantiate the old advice to permit whooping-cough patients, free from fever, to be out in the open air as much as possible on still, sunny, summer days. In the confined space of a sick-room, the air loaded with carbonic acid gas, and the volatile ammoniacal particles of the various excretions, is in itself sufficient to induce cough. Out in the open air, on the contrary, where nature furnishes in every leaf an apparatus for the generation of oxygen, not only is such injurious effect prevented, but the greater liberation of carbonic acid gas, by promoting the respiratory process, will have a calmative effect upon the paroxysm. When the state of the weather is such as to prevent the egress of the child into the open air, it is advisable on the same grounds to place in the chamber some many-leaved, blossomless plants, meagre in perfume, so as to increase the proportion of oxygen in the atmosphere of the apartment; particularly for a few hours after a meal, because at this time the production of carbonic acid in the organism reaches its maximum. For similar reasons, such articles of nutrition should be selected as are least productive of carbonic acid gas, and which, by their high oxidation, require but a small quantity of oxygen for their combustion in the system. Therefore the diet most appropriate under such circum-

stances is one rich in fatty constituents, such as milk, sugar, and starches. On the same principles great attention should be paid to the condition of the skin, by the use of frequent ablutions, baths, etc.*

The inconvenience often attendant upon sending children with whooping-cough to the gas-works, a practice which he had pursued with good effect in 1864, led Dr. Lochner† to the attempt to employ at home, in the case of his own son, one of the substances contained in the purifying chambers of the gas-works; and he selected benzine, with the vapor of which he kept the room impregnated by pouring a few drops upon the bed of the patient. In the case of his own child, in whom the paroxysms were very violent, though only numbering five or six in the twenty-four hours, the disease lasted but six days. He also employed the benzine internally, ten or fifteen drops daily in a little water; and when the child was sleeping, sprinkled a few drops upon the bed.

CHLORINE.

It has been asserted that paper-makers, though exposed to the fine dust from the rags, and the like, are, as a class, peculiarly exempt from phthisis, and on account of their exposure to the fumes of chlorine; and it is probable that this circumstance originated its suggestion as a remedial agent by inhalation.

Gannal, observing in 1819 that in a bleaching establishment, workmen who suffered under diseases of the chest, were visibly improved, ascribed the amelioration to the inhalation of air containing this gas, and he was

* (Jahrb. für Kinderheilkunde, 1862; Med. Neuigk. für Aerzte, Erlangen, 1862, No. 22); Lewin, op. cit., p. 202.

† Gazette médicale, Oct. 20th, 1866.

led to institute experiments upon consumptives. His results were good. He read a memoir on the subject, before the Parisian Academy of Sciences, Jan. 8th, 1828, exhibiting an apparatus which he had devised for administering inhalations of the gas, and recommending its use as a curative agent in phthisis.*

The inhalation of chlorine was recommended by Bretonneau in diphtheritis, when the false membrane had entered the larynx.

Laennec mentioned its use favorably in his clinical lectures.†

Sir James Murray has stated‡ that a friend of his had observed beneficial effects in consumption, among his workmen, from exposure to the inhalation of a watery vapor strongly impregnated with chlorine.

Dr. Cottereau§ reported thirteen cases in which all the signs were decisive of phthisis, and in which recovery ensued under inhalations of chlorine. One of these is described as a remarkable case of consumption of the worst kind. This patient, some two years after having been cured of his consumption, died from acute inflammation of the mucous membrane of the stomach and small intestines, without any derangement of the respiratory system; and the post-mortem examination revealed the presence of the old cicatrices, and some crude tuberculous granulations.

* Two Memoirs on the Inhalation of Chlorine, etc. Translated by W. H. Potter. London, 1830.

† Revue méd., 1823, 1, p. 296.

‡ (A Dissertation on the Influence of Heat and Humidity, etc. London, 1829, p. 126); Corrigan, Dublin Jour. Med. Sci., March, 1839, p. 96.

? De l'emploi du chlore gazeux dans le traitement de la phthisie pulmonaire; Arch. gén. de méd., 1830, xxiv, p. 347.

Sir Charles Seudamore, who tried chlorine in several instances of phthisis, found it inferior to iodine, his favorite remedy.

Louis was willing,* on the evidence of Gannal, Murray, Seudamore, and Cottereau, to acknowledge the palliative effects of chlorine (and iodine) in phthisis, but he subsequently reported† that in a number of experiments with more than fifty consumptive patients at La Pitié, the Hôtel Dieu, and elsewhere, he had not obtained any successful result from the inhalation of chlorine gas; though he has elsewhere admitted that singular advantage may be obtained from chloruretted inhalations in certain cases of chronic bronchitis, even where the general symptoms closely resemble those of phthisis.

Dr. Elliotson‡ found great mitigation from inhalations of chlorine in two cases of phthisis, and found them secure greater amelioration than narcotics or any other means then employed.

Dr. A. T. Thompson§ considered chlorine the best topical expectorant and the most salutary excitant to the mucous membrane that had yet been inhaled. He speaks highly of its palliative influence in phthisis, having found it give such relief, even in advanced cases, as "to have scattered flowers on the borders of the grave."

Toulmouche|| found inhalations of chlorine to effect

* Pathological Researches on Phthisis, translated by Cowan, Washington, 1836, p. 287.

† Recherches anatomiques, pathologiques et thérapeutiques sur la phthisie, Paris, 1843.

‡ The Lancet, 1830-31, ii, p. 198.

§ Materia Medica.

|| Arch. gén. de méd., 1834, iv, p. 576.

temporary improvement in phthisis, facilitating expectoration, and improving the appetite. In chronic bronchitis it yielded him the most brilliant results. In one hundred and forty-one cases of acute bronchitis* recovery ensued in from five to fifteen days. In sixty-five cases of chronic bronchitis, four of which were complicated with pulmonary emphysema, the results were likewise unusually satisfactory ; recovery ensuing in from sixteen to twenty-seven days. He employed a simple inhaler (Fig. 3, p. 21) one-fourth filled with warm water, to which from ten to forty drops of chlorine-water were added. The inhalations were administered from four to six times a day, each inhalation occupying from ten to fifteen minutes.

Dr. Stokes found these inhalations prejudicial in phthisis, being too provocative of irritation. He found them beneficial, however, in correcting fetor in gangrene of the lungs. Laennec and others also failed of success with chlorine inhalations in phthisis, and even found them occasionally injurious. Morton, of Philadelphia,† and Little‡ found them more injurious than useful.

Inhalation of chlorine is said to be a most efficient agent in poisoning by hydrocyanic acid, and in poisoning by sulphuretted hydrogen.§

Chlorine gas, in proper dilution for inhalation, may be evolved by mixing one or two drachms of the chlorine-water with a couple of ounces of hot water, and placing the vessel in a hot bath, or over a flame ; or it

* Gaz. méd., Paris, 1838, No. 26 ; Waldenburg, op. cit., p. 687.

† Illustrations of Pulmonary Consumption, Philadelphia, 1834.

‡ Dub. Med. Jour., March 1st, 1834.

§ Dunglison's New Remedies, 7th Edition, p. 202.

may be inhaled by adding water to chloride of lime in a Wolfe's bottle or other inhaler.

Dr. Corrigan employed a special apparatus,* which has already been described (p. 31). He directs that eight ounces of a saturated solution of chlorinated lime be poured into the glass globe; and into the water of the porcelain dish, two ounces of the diluted sulphuric acid of the Pharmacopœia. As the solution drops, the acid seizes on the lime, and the chlorine is evolved in connection with aqueous vapor.

Prof. Joseph Pancoast, of Philadelphia,† reports the cure of a particular form of aphonia by means of the inhalation of the vapor of chlorine. The form of aphonia is that inferred to be due to partial paralysis of the intrinsic muscles of the larynx.

As an inhaling apparatus, Dr. Pancoast used the ordinary tubulated glass retort of the chemist, with a glass funnel having some filtering-paper at the bottom. In the bowl of the retort he placed a solution of the chloride of soda, or lime. Into the glass funnel was put a weak solution of muriatic acid in water. As the dilute acid fell drop by drop into the bowl of the retort, chlorine was very gradually liberated and breathed from the end of the instrument.

In using this apparatus, some care is required that the acid solution should not be allowed to drop too freely on the salt in the bowl of the retort, so as to develop the gas too freely. But the patient has the means of protecting himself against too strong an impression of the chlorine on the glottis, by diluting it with air drawn

* Dub. Jour. Med. Sci., 1834, 43, p. 94.

† Trans. Am. Med. Ass'n., 1850, vol. iii, p. 135.

in through the nostrils, a measure to which he would instinctively resort.

"The first case in which this method was employed, was a healthy young country girl, who had contracted a severe cold by remaining in a damp spring-house. The aphonia had lasted for six months, resisting every sort of treatment.

"She was placed upon the inhalation of chlorine, continued for some minutes, and repeated two or three times a day, according to the degree of irritation it produced in the throat and larynx. From the first trial, the patient's voice improved, and in three days had become very nearly as strong as ever. A couple of months after her return to the country, another cold was followed by a similar case of aphonia. The patient again breathed the dilute chlorine vapor for a few times, and had her voice restored.

"The second case was that of a well-known practitioner whose voice had been lost for about seven months, so that he was unable to practice his profession. Besides exhausting the means more ordinarily resorted to in these cases, he had made, without any good effect, repeated trials of a strong lunar caustic solution applied with a sponge to the glottis.

"His voice began to improve from the first trial of the chlorine. The improvement was steady, but more slow than in the case above detailed, a week or ten days elapsing before his voice was restored to its natural strength."

Dr. Pancoast very properly considers that the chlorine acts merely as a local stimulant, and that iodine, or any other exciting vapor would effect similar results.

Chlorine has likewise been recommended by inhalation in diphtheria. Mr. C. F. Hodson recommends the inhalation of the vapor of boiling water mixed with a portion of a solution of chlorinated lime.*

IODINE.

The close resemblance between tuberculosis and scrofulosis, and the well-known alterative effects of iodine

* (Brit. Med. Jour., March 8th, 1859); Am. Jour. Med. Sci., April, 1859, p. 545.

upon diseases of the latter character, especially as they affect lymphatic and other glands, naturally led to the employment of the same remedy in pulmonary consumption; and the volatile nature of iodine suggested its employment by inhalation, for the treatment of affections of the respiratory organs. This vapor has been found of decided efficacy in confirmed phthisis, and in certain forms of catarrh, by many well-known authorities.

Laennec, attributing the infrequency of pulmonary tuberculosis on the English coast to the iodized vapor escaping from sea-weed, and the beneficial effects of sea-air in phthisis to the iodine present in such an atmosphere, tried, in 1825, the effect of an artificial sea-air, from which he anticipated important results. He kept twelve patients in this atmosphere for four months. The disease remained stationary in all of them, and the emaciation and hectic fever underwent remarkable diminution in several of them. Nine of these patients, believing themselves cured, declined to remain any longer in the hospital. The three patients remaining under observation could not be longer provided with the sea-weed in consequence of the difficulty of its transportation incident to the season (spring), and the disease took a rapid course the moment the varec gave out, and soon terminated fatally.

Direct inhalations of iodine were employed by Berton in 1828, who read a paper on the subject before the Parisian Academy of Medicine in 1829.* Dr. Berton's method consisted in placing into a flask with two openings some dilute sulphuric acid, to which is added a quarter or half a grain of the hydriodate of potash; the

* Arch. gén. de méd., xix, p. 134.

iodine vapors are promptly disengaged, and are inhaled by the patient from one of the tubes from the flask, the process of inhalation occupying four or five minutes, and being repeated as often as desirable, even to the number of ten times a day.

Sir James Murray,* as the result of his experience, felt assured that he had seen beneficial results from inhalation of the vapor of iodine in many instances, some of them undoubted cases of phthisis. He had always observed at least a temporary improvement of the general condition; the cough becoming less severe, expectoration more free, and sleep quieter. The plan employed by him was to place a vessel containing iodine in such a position as to become traversed by a current of steam escaping from a vessel in its neighborhood; or else he placed an open capsule, with moistened iodine, in a vessel of hot water. The patient, in this manner, breathed an iodized atmosphere continuously. He inquires, very pertinently, whether the favorable results are not in part due to the equable temperature maintained in the patient's apartment?

Sir Charles Scudamore, one of the most enthusiastic advocates of the treatment under consideration, found the irritating qualities of the vapor subdued by the addition of a small quantity of tincture of conium at the time of employing the inhalation, a higher heat being necessary to liberate the vapors from the conium than is necessary with iodine alone.† Hundreds of consumptives treated by this method, though not cured, had ex-

* A Dissertation on the Influence of Heat and Humidity, etc. London, 1830.

† The Lancet, 1830-31, p. 189.

perienced considerable relief.* This observer, after ten years' experience with iodine inhalations, had acquired increased confidence in their efficacy.† His formula at this time was six grains each of iodine and iodide of potassium, with two drachms of alcohol to five ounces of distilled water, adding a little tincture of conium at the time of mixing the solution of iodine with the water for inhalation. He began with a drachm or so of the iodine mixture, two or three times a day, increasing the dose, if necessary, to as much as four drachms, and prolonging the duration of the inhalation. The apparatus employed by Seudamore has already been described (p. 23).

Dr. Elliotson's experience with iodine in consumption had not been attended with results in any instance promising recovery, but he advised further continuance of the treatment.‡ Dr. Little not only failed to meet with any success with these inhalations, but even found them excite acute inflammation of the trachea.§ Stokes|| expresses his reprobation of the practice in the strongest language. Baudelocque, in 1838,¶ likewise derived but little benefit from them. The experience of Dr. Pereira**

* Cases Illustrative of the Efficacy of various Medicines administered by Inhalation in Pulmonary Consumption, certain Morbid States of the Trachea and Bronchial Tubes, attended with distressing Cough, and in Asthma. London, 1830.

Cases Illustrating and Confirming the Remedial Power of the Inhalation of Iodine and Conium in Tubercular Phthisis, and various Disordered States of the Lungs and Air-passages. London, 1835.

† London Med. Gazette, February, 1840.

‡ The Lancet, 1830-31.

§ Dub. Med. Jour., March 1st, 1834.

|| Diseases of the Chest, Philadelphia, 1837, p. 296.

¶ Gaz. hebdom., 1854, i, 21.

** Materia Medica, Philadelphia, 1843, vol. i, p. 232.

in phthisis, as well as in other chronic pulmonary complaints, had not been favorable.

Piorry has been one of the chief advocates of the treatment of phthisis by inhalations of iodine,* and he treats of the method in terms of very high encomium. In a paper read before the Parisian Academy of Medicine, M. Piorry, after mentioning the circumstances inducing him to employ inhalations of iodine in the treatment of phthisis, states that the results of the experiments, instituted by himself in conjunction with M. Deyne, an interne of his service, were very satisfactory. A striking amelioration took place in many of their patients, this amelioration being permanent, inasmuch as several patients, whose cases had been mentioned in his work on Practical Medicine, were still in the enjoyment of good health.

The successful treatment of hydrocele and tuberculous diseases of the testicle, by injections of solutions of iodine, justified the inference of anticipating similar benefit in pulmonary excavations; but the difficulty, not to mention the temerity, of attempting the injection of tincture of iodine into a pulmonary cavity,† or into the air-passages, led M. Piorry to the plan of employing the vapor of iodine. Sometimes the crystals of iodine were employed to evolve the vapor, and sometimes the tincture of iodine was used. In the former instance, one or two seruples of iodine were placed in a wide-mouthed quart jar, from

* *Gaz. des hôp.*, 1850, 84; *Arch. gén. de méd.*, March, 1854, p. 361; (*Comptes rendus*, January 24th, 1854); *Ranking's Abstract*, 1854, xx, p. 70.

† Since performed by Mosler, *Berliner klin. Woch.*, 1873, No. 43; *London Medical Record*, Jan. 28th, 1874, p. 52; and by Pepper, *Philadelphia Med. Times*, March 14th, 1874, p. 369.

which the vapor was disgorged spontaneously with more or less rapidity, according to the degree of heat and moisture of the atmosphere. In other instances, one to three ounces of the tincture of iodine were poured into the jar, which was then heated until the vapors of iodine and alcohol were liberated. The patients breathed the vapors contained in these recipients, taking one deep sighing inspiration at a time, and repeated the effort from one to two hundred times daily, at appropriate intervals. Several successive inspirations will produce pain in the larynx and bronchi, with cough, although single inspirations do not produce much irritation.

Like Laennec, who surrounded the bed of his consumptive patients with varec, to insure continuous inhalation of the iodinized vapor, Piorry, too, desired that his patients should inhale iodine even during sleep. For this purpose he had several saucers containing iodine placed about the patient's pillow. In the hospital he attached a number of vials of iodine to the iron frame supporting the bed-curtains, so as to saturate the air with iodine, which is given off in sufficient quantity to blue the starched curtains and produce various tints on the iron of the bedsteads.

Piorry states, that if a moist starched paper is interposed between the jar containing iodine and the patient's mouth, as he takes an inspiration, it turns blue; while the same air breathed upon the paper, after having traversed the lungs, causes no change; from which fact he infers, that the iodine which enters the lungs is absorbed there, during the brief sojourn of the air in the air-vesicles.

The treatment of Piorry's cases was not confined to the iodine inhalations. Most of them took from twenty to sixty grains of

the iodide of potassium by the stomach daily. In cases of supposed adhesions, frictions were resorted to with tincture of iodine, diluted with nineteen parts of water. Other remedies were given in some cases to fulfil various indications; while a nutritious and reparative diet was employed, a regimen to which Piorry gives a preference over all the whole category of remedies except iodine.

Thirty-one patients were thus treated during a period of two years, all presenting in different degrees the symptoms commonly attributed to pulmonary phthisis; the majority of them with diarrhoea, and many of them with laryngeal involvement. In every instance the plessimetric and stethoscopic signs were positive.

In order to determine with precision the effects of the iodine, some charts were prepared, upon which were marked exact delineations of the parts diseased, and representations of the variations in sound upon percussion, as they occurred from day to day. After periods varying from four, six, or twenty days, to from six weeks to four months of the iodine treatment, there was in almost every case a diminution of the extent of the surface over which there was at first feebleness of respiration, dulness, resistance, etc., while at the same time, the stethoscopic signs indicated an amelioration in the condition of the condensed portions of lung. Numerous patients with cavities in the lungs were apparently cured. The ultimate results were: decided amelioration in the symptoms and anatomical characters in twenty cases; disappearance of the anatomical characters and of most of the symptoms in seven cases; death with or without amelioration in four cases.

After some reflections as to the manner by which the iodine operates in the case of phthisis, M. Piorry concludes as follows:

1st. The inhalation of the vapor and tincture of iodine is useful in the cure of phthisis;

2d. In many cases, such inhalation is followed by a diminution in the extent of the indurated parts surrounding tuberculous deposits, and an amelioration in the general symptoms;

3d. It is probable that tubercle itself disappears under the influence of iodine inhalations;

4th. That inhalations of the tincture of iodine may promote the cure of tuberculous cavities;

5th. That after the softening of tubercles, the resulting cavities may cicatrize spontaneously;

6th. That compression of the thorax over the points of disease indicated by percussion and auscultation, may contribute to the cure of the local lesion, and to the prevention of pyæmia;

7th. That iodide of potassium administered internally, and frictions with diluted tincture of iodine over adherent portions of the lung, are also of great utility.

Some years later, Pierry reported continued success with this method of treating consumption.*

Huette, of Montarges, in 1849,† proposed the use of hydriodic ether in all cases in which it was desirable to saturate the system quickly with iodine, and when we wish to carry this agent directly into the lungs. A spoonful of water, mixed with seven or eight drops of the ether, is put into a wide-mouthed jar. The ether falls to the bottom, and the patient inspires the air contained in the upper part of the glass, while he holds the bottom of it in his hand to favor the volatilization of the

* Gaz. des hôp., March 21st, 1861.

† (Thèse, Paris, 1849), The Prescriber's Complete Handbook, London, 1858, p. 251.

ether. The whole of the ether is generally absorbed in ten minutes; and in a quarter of an hour afterwards iodine is found abundantly in the urine, and it may be found there for some time.

M. Simon relates* the results of a number of cases of phthisis pulmonalis treated by M. Chartroulle with inhalations of iodine, a practice very frequent in Belgium. Under his directions, twenty-eight hospital patients were treated by the inhalation of the vapor of pure iodine; and of this number only eleven could be said to have derived no benefit from the treatment. In these unsuccessful cases the pulmonary lesions were not modified, but still the symptoms were not aggravated in any instance. In opposition to the statement that iodine vapor produces haemoptysis, it was found that pulmonary hemorrhage ceased more rapidly under this kind of treatment than under other plans which are more generally employed. Seventeen patients derived positive benefit from the iodine treatment, and this improvement was observed not only in relation to the general symptoms, but also to the pulmonary lesion itself, as was proved by percussion and auscultation. Out of the seventeen patients, but four might be considered as actually cured. One of these cases of cure is the following:

A youth, sixteen years of age, entered the hospital in such an alarming condition that at first the physicians hesitated to submit him to the iodine inhalations. He was in a state of great emaciation, and his skin was almost constantly covered with profuse perspiration; he had diarrhoea, which had lasted for two months, and he had repeatedly suffered from haemoptysis. There were very extensive indurations in the lungs, and at the apex of the

* Brit. and For. Med.-Chir. Rev., July, 1861, from Union médicale, March 16th, 1861.

right lung there was a cavity of some size, as was shown by very obvious *gargouillement*. The expectoration also was characteristic. After resting a few days, this young man was subjected to the iodine inhalations, and all the symptoms which had appeared so serious were soon modified in a most remarkable manner. The general symptoms disappeared first, and the body recovered its plumpness with great rapidity. The perspiration, diarrhoea, fever, cough, and expectoration, were soon relieved or removed; and six weeks after admission into the hospital the patient went out quite well.

Several other cases of the same nature are recorded from both the public and private practice of M. Chartrouille, and in all of them the beneficial results of iodine inhalations are remarkably exhibited. Dr. Simon, who relates the cases, attributes a great part of the efficacy of the treatment to the apparatus employed for inhalation, which, however, is not described in the paper.* By this apparatus, it appears, a degree of precision is given to the treatment, which consequently becomes the more efficacious, for a dose of the vapor may be estimated with exactness, and the remedy may be made proportionate to the intensity of the disease and the strength of the patient.

Lewin† had employed vapor of iodine in phthisis several times without any favorable results; but all his cases were in the advanced stage.

The inhalation of iodine vapor has been employed in coryza:

An army surgeon, M. Luc, seized with very bad coryza, attended by fever, severe cephalalgia, and excessive secretion, determined upon trying the effect of the inhalation of iodine vapor. The coryza first appeared at 9 A.M., and the inhalations were com-

* Chartrouille originally (1851) recommended ioduretted cigarettes.

† Op. cit., p. 202.

menced at 3 p.m., being repeated every three minutes during an hour, each inhalation lasting about a minute. The headache was first relieved, the sneezing then occurred less frequently, the amount of secretion diminishing; and by 6 p.m. all traces of the coryza had disappeared, except a little burning sensation in the throat.

Several army officers subsequently tried the means with the same results. The inhalation is effected by placing a bottle of tincture under the nose, the hand supplying warmth enough to vaporize the iodine.*

Dr. Ringer recommends the following method of administration in patients troubled with daily coryza:† "A jug of the capacity of a quart is heated by rinsing with boiling water; then partially filled with boiling water, into which from twenty to thirty drops of the tincture of iodine are poured. The jug and the head of the patient are covered with a towel. The inhalation is used night and morning for five or more minutes."

Dr. A. P. Merrill, of New York, formerly professor of *Materia Medica* in the Memphis Medical College, and editor of the *Memphis Medical Recorder*, has for a number of years made extensive use of the inhalation of the vapors of iodine in mucous inflammations of the trachea and bronchi, led to the treatment by the happy results previously obtained in his own case and that of others, by its local application, in a convenient form, in cases of chronic pharyngitis and laryngitis.‡

Dr. Merrill employs the vapor disengaged directly from the crystals of iodine, which are sufficiently volatile

* Rev. méd., August 31st; Med. Times and Gazette, November 11th, 1865; The Med. Record, March 1st, 1866.

† Handbook of Therapeutics, New York, 1875, p. 83.

‡ These cases are reported in the *Memphis Medical Recorder*, vol. i, 1852-3, pp. 8, 21, 113; vol. iii, 1854-5, pp. 133, 187, 228, 285; vol. iv, 1856, pp. 252, 377.

in a current of cold air to afford all the strength of vapor that can be conveniently borne by the patient. I make a few extracts from some communications on this subject, kindly furnished me by that gentleman. "In a case of such inflammation beyond the reach of the brush, I found a patient inhaling the vapor of gum camphor through a common quill, but without much effect. I added a few grains of iodine to the camphor, and then the relief obtained was more decided; but in applying this combination to other cases, I met with a difficulty in the liquefaction of the mixture, and then determined to use each remedy separately, by placing it within a small cane tube, with a little coarse wool in each end to prevent the escape of the medicine. I have used tubes of glass, also, but found them to hold the remedies less securely. The cane tubes have answered an excellent purpose, whether employed through the medium of the mouth or the nasal passages; but more recently I have substituted tubes made of hard rubber, so rounded at the ends as to prevent irritation, and the vapor escapes through several perforations at the extremity. With these tubes, which unscrew at the middle for the introduction of the iodine, the teeth, tongue, etc., are protected from any disagreeable effects of the vapor, and the current may be made to impinge in any desired direction.

"Great benefit is derived from iodine inhalations in the more acute affections of the nasal membranes, such as coryza, hemorrhage, and catarrh. They relieve the habitual catarrh of old people, and are advantageous to public speakers and singers, whose vocal organs have become debilitated from excessive exercise in their voca-

tions, and which sometimes show a tendency to œdema of the glottis, and terminate in aphonia."

Dr. Merrill details* an interesting case of symptomatic bronchial irritation, in which the iodine inhalations were very beneficial. These were made with tubes of cane in the manner previously described. He considers that the iodine acts in chronic cases by exciting a watery secretion which disengages the viscid mucus, which frequently induces coughing by its titillation; and that it relieves hyperæmia and hypertrophy. He has found benefit from inhalations of iodine vapor in cronp, in œdema of the glottis, and in aphonia.

In cases of children, and people unwilling or unable to inhale properly, he attaches a gum hand-bellows by a rubber tubing to the tubes, and thus forces the vapor into the nasal or laryngeal passages.

Dr. Merrill has kindly furnished me with the following notes of a case of profuse bronchorrhœa, which was suppressed by inhalations of iodine:

"Mrs. McL., aged seventy years, had suffered for several months with cough, constipation, and œdema of the feet and legs, with incontinence of urine. She complained especially of excessive expectoration, which had reduced her almost to a skeleton, and it was with difficulty she could walk across the room. I did not see the matter expectorated, which was so offensive that she declined saving it, but both she and her daughter estimated the quantity latterly at a pint to a pint and a half every morning, for it was only in the morning that her cough troubled her. Beginning at three to four o'clock, it continued several hours, during which time the expectoration was free and profuse; and she often passed the remainder of the day without coughing at all.

"I gave her an inhaling-tube, charged with iodine, to be used frequently during the day and night, and directed her to take one-tenth of a grain of arsenious acid three times a day, together

* Am. Jour. Med. Sci., Jan. 1866.

with half a grain of calomel at night. This course was continued twenty days with progressive improvement, when (June, 1867) she was entirely relieved of the bronchial disease, and the iodine inhalations were suspended."

Inhalations of iodine have been recommended in diphtheria by Dr. J. Waring Curran.* His formula consists of a grain each of pure iodine and iodide of potassium, with one drachm of alcohol in an ounce of distilled water. One drachm, gradually increased to four, is added to a pint of vinegar, in which a handful of dried sage has been infused. The inhalation is kept up for from eight to twelve minutes, the temperature being maintained equable by a spirit-lamp; and it is repeated every two hours.

Whitelaw has recommended inhalations of iodine in fetid breath.†

Leigh rubbed iodine ointment upon the chest and into the axillæ, so that the patient could breathe the vapor by placing his head beneath the bed coverings.‡

It must not be overlooked, in considering this subject, that much of the benefit derived from painting tincture of iodine, and the like, over portions of the chest in cases of pulmonary phthisis, chronic bronchitis, etc., may be justly attributed to inhalation of the vapor of the iodine thus employed. This is especially probable in cases in which the iodine is applied at night.

I have had considerable satisfactory personal experience in treating the chronic laryngitis of tuberculosis with inhalations of iodine in combination with carbolic

* The Lancet, Sept., Oct., 1867, pp. 357, 513; 1868, October 16th, No. 17.

† Med. Times and Gaz., Oct. 1st, 1870.

‡ London Med. Gaz., xxviii, p. 394.

acid, a grain or two of the latter, with ten or more drops of the compound iodine water or tincture of iodine, thrown upon hot water in any convenient vessel or inhaler, and repeating the inhalations once or twice in the day for from five to ten minutes at a time.

IODOFORM.

Iodoform, dissolved in ether, was recommended by Righini as of great service in retarding the progress of phthisis.* I am not aware of any further application of the remedy by inhalation.

BROMINE.

Bromine vapors by inhalation have been recommended in croup and diphtheria. Leuthlen† employed in croup a solution of four parts each of bromine and bromide of potassium in two hundred parts of distilled water. A sponge saturated in this solution is held under the nose of the patient for from five to ten minutes every hour. Schütz‡ also recommends it in croup and diphtheria. He employs the same formula, placing the sponge in a cone of drawing-paper and holding it over the mouth and nose as in chloroformization; the inhalation continuing from five to ten minutes, and being repeated every hour or half hour.

Gottwald§ reports two cases of croup, in which trach-

* (*Jour. de chim. méd.*, February, 1853; *Assoc. Med. Jour.*, April 1st, 1853); *Am. Jour. Med. Sci.*, July, 1853, p. 192.

† *Würtemburg Correspbl.* 39, 1864; *Waldenburg*, op. cit., p. 683.

‡ (*Ueber einige Krankheiten der Halspartie*, Prag. 1865; *Wiener Wochenschr.*, 33ff, 1871), *ibid.*

§ (*Deutsche Klinik*, 18, 1872), *ibid.*

ectomy was indicated, cured in this manner, without the operation; fourteen cases of recovery of diphtheria of "the fauees," and four deaths in complicated diphtheria.

Dr. Ch. Ozanam reports remarkable success (recovery in all but four or five out of one hundred and fifty cases) with bromine by stomach and air-passages in membranous croup.* He takes a bowl of boiling water and places over it a funnel of glass or of paper. He puts into the water a large pinch of bromide of potassium or of common salt, and afterwards adds gradually, two or three times within the space of from five to ten minutes, a teaspoonful of an aqueous solution of bromine about one drop to the ounce. The patient must inhale slowly and deeply the vapor, which, mixed with the steam of the water, does not produce any irritation.

It is highly recommended by Dr. F. Vogelsang in the nervous stage of whooping-cough; the atmosphere of the patient's apartment being kept impregnated with the vapor of bromine.†

SULPHUR.

Sulphur vapors have been employed by inhalation from very early times. Their popular virtues as disinfectant and antimiasmatic have been recorded by Homer.‡ Galen is well known to have recommended patients with various affections to frequent the vicinity of Mt. Vesuvius, to respire the air loaded with its sul-

* Rev. de thérap., January 1st, 1868; Am. Jour. Med. Sci., April, 1868, p. 537.

† Memorabilien, 1874, No. 10; Brit. Med. Jour., April 17th, 1875, p. 509.

‡ (Odyssey, xxii, 481); Waldenburg, op. cit., p. 567; (Iliad, lib. xvi); Percira, Materia Medica, Phila., 1843.

phurous emanations. They were also employed by Celsus, even in the paralysis after apoplexy. Avicenna employed the fumes of sulphur in asthma.*

The manufacture of sulphuric acid, it is asserted by M. Baumes,† protects those employed against phthisis, even restoring to health those who seem to have been predisposed to the disease.

Of recent years the inhalation of sulphurous acid vapors has again attracted attention. They are extensively employed on the continent of Europe; inhalatoriums being established at many of the sulphurous springs visited as summer and health resorts. They are employed in superficial inflammations of the entire respiratory tract generally, in phthisis, in chronic bronchitis, in emphysema, asthma, and whooping-cough.

Dr. James Dewar,‡ of Kirkealdy, speaks highly of the benefit of using the sulphurous acid fumes in the treatment of typhoid, ephemeral, and scarlet fevers, and in diphtheria, gout, and rheumatism. He saturates the atmosphere of the patient's room with the vapor.

Dr. W. Jackson Cummins§ also speaks highly of their use in the treatment of zymotic diseases, diphtheria, searlatina, etc. He burns sulphur day and night in the room and about the house.

The inability of certain organic germs to live in an

* Floyer, *On Asthma*, London, 1717, p. 169.

† (Maygrier, *la Phthisie*, Dict des Sci. méd.); Coxe, *On Inhalation*, Philadelphia, 1845, p. 35.

‡ Dublin Med. Press and Circ.; Medical Record, New York, 1866, p. 395. See also, *On the Application of Sulphurous Acid, Gaseous and Liquid, to the Prevention, Limitation, and Cure of Disease*; Edinburgh, Tenth Edition, 1868.

§ Dub. Quart. Jour., August, 1869, p. 219.

atmosphere of sulphurous acid gas is considered the means of protection in zymotic disease.

My own experience in diphtheria, during an endemic some years ago, was decidedly favorable as to the protective, and, in some instances, apparently the curative value of sulphurous acid fumes. In chronic bronchitis, on the other hand, it has been less efficacious, in my experience, than other treatment.

Sulphurous acid fumes may be readily evolved by igniting two parts of flowers of sulphur with one part of charcoal. Dr. Dewar* states that a very simple method is to put a few red cinders into a kitchen-shovel; to set this upon a wooden stool upon the floor, and then to sprinkle "flour of sulphur" from time to time upon them until the room is not inconveniently filled with fumes.

AMMONIUM.

The vapors of ammonia and of carbonate of ammonium have long been employed to rouse, by their irritating properties, a patient in case of sudden syncope or fainting from any cause. Pure ammonia is irrespirable, but mingled with a large proportion of atmospheric air it can be utilized for inhalation. Thus vapor of ammonia either from water of ammonia pure, or diluted with from one to twenty or more parts of water, has been recommended by Harwood and others in chronic hoarseness and aphonia. Smeet† has recommended its use in chronic hoarseness, especially that form following influenza, in relaxed conditions of the throat generally, in the early stage of tonsillitis, and in asthma. Its irri-

* Op. cit., p. 23.

† London Med. Gaz., April, 1843, p. 59.

tant influence on the mucous membrane excites a serous secretion which facilitates the expectoration of mucus and the like. On the same grounds it is of use in coryza, acute and chronic. It is usually injurious, however, in febrile and acute inflammatory affections. It is said to be antidotal to the vapors of bromine, prussic acid, and carbonic acid gas.

The vapor of carbonate of ammonium is of great advantage, with some subjects, in the early stage of coryza, precipitating copious serous secretion. It is also said to be abortive when resorted to promptly.

It has also been employed with some success in asthma. Tronseau sometimes made this use of it, placing a quantity of it by the bedside of the patient.

The vapor of ammonia has been recommended in croup, when asphyxia is imminent and emetics fail to act, by Dr. Daguillon, of Oran, who reports* four cases of success from its use. His plan is to take a piece of sponge of the size of an almond, fixed upon a piece of wire, and plunge it into water of ammonia until it is thoroughly softened. It is then carried into the pharynx, care being taken not to touch the tonsils, and held there a sufficient time for the effect of the vapor to become sensible in the countenance. A glass of water kept close at hand then serves for washing out the parts at the back of the mouth. These inspirations are repeated three times, with short intervals. The presence of the ammoniacal vapors in the larynx and bronchi immediately determines a hypersecretion of mucosities, which the infant most frequently rejects by vomiting. The

* Gaz. Hebdo., 1870, No. 30; Ranking's Abstract, January, 1871, p. 65.

expectoration becomes more abundant, the oppression diminishes, the cough and voice become less hoarse, and the general symptoms are relieved.

Mr. John Grantham recommends the vapor in the treatment of whooping-cough.* He employs it at bedtime; an ounce of the water of ammonia being put in a gallon of boiling water, in an open pan, steam being evolved by the introduction of a red-hot half brick.

The vapor of ammonia, in combination with carbolic acid, has been recommended by Hager in acute coryza. Its efficacy has been substantiated by Brand† and Waldenburg.‡

Hager's formula contains one part of carbolic acid, three of absolute alcohol, one of caustic solution of ammonia, and two of distilled water. Waldenburg's formula is one part each of carbolic acid and alcohol, with two of the caustic solution of ammonia; the proportions being varied to suit special cases. Brand prefers to place a few drops of the solution on three or four folds of blotting-paper, which the patient places in the palm of his hand; and then he inspires the vapor deeply through nose and mouth as long as it rises, keeping his eyes closed. It may, however, be inhaled from an open vessel.

Ammonia, as already mentioned, is one of the products of the purification of illuminating gas, employed in the treatment of whooping-cough.§

CHLORIDE OF AMMONIUM.

Sal-ammoniac has been recognized as a beneficial

* Brit. Med. Jour., 1871, September 16th, p. 323.

† Berlin klin. Woch., 1872, No. 12.

‡ Op. cit., p. 657.

§ See under head of Carburetted Hydrogen.

agent in the treatment of affections of the throat and respiratory organs, from the very earliest periods in the records of medicine.

It was first employed by inhalation, according to Lewin, by Prof. Fuchs, of Göttingen.* In the published reports of the Göttingen Clinics for 1838 and 1839, it is recorded that Prof. Fuchs employed the inhalation of the vapors from sal-ammoniac in the treatment of chronic catarrhs of the respiratory organs; the fumes being evolved by placing the salt upon a heated porcelain plate. Lassègue, more recently, resorted to the same means in France, with satisfactory results. At a later date, the fumes from sal-ammoniac were highly recommended by Dr. Geiseler† in chronic pulmonary catarrh; and his method of administration is as follows: Two or three teaspoonfuls of the salt are placed in a Hessian crucible and heated over a Berzelius lamp, the patient sitting in front of the apparatus and inhaling the vapor; the chamber soon becomes filled with the fumes of sal-ammoniac, and for some time (one to two hours) after their disengagement has been discontinued, the invalid remains in the strongly impregnated atmosphere. This is repeated once or twice in the twenty-four hours.

Direct inhalations give better results than breathing the strongly impregnated atmosphere of a room in which the fumes are being disengaged. Paroxysms of cough, with profuse expectoration, ensue only during the earlier sittings; later, there results merely a sensation of warmth in the air-passages.

* Schmidt's Jahrb., 1841, xxxiii, p. 319.

† Henle and Pfeuffer's Ztschr., 1854, v. 3.

Dr. Paseh* places a drachm of the caustic water of ammonia in a saucer, in which he places a watch-glass containing from one-third to one-half of a drachm of pure muriatic acid. White fumes of sal ammoniac are immediately evolved, and, as in other cases, may be inhaled with or without the use of a funnel, to direct them into the mouth. A great excess of ammonium is produced by this method, but it is not considered injurious. In the lungs of catarrhal patients there always remains a quantity of carbonic acid gas which is not exhaled, and which, remaining in the minutest bronchi, becomes converted into carbonate of ammonium as the sal ammoniac reaches it.

I have often instructed patients merely to place a pinch of the salt upon an iron spoon, and hold it over the flame of a gas or spirit-lamp; the fumes are evolved in a few moments, and the spoon can be removed and the fumes inhaled, with or without the use of a funnel, until evolution ceases; when the process is to be renewed until the required amount has been employed.

I have found these inhalations of extreme value in cases of dryness of the pharynx (pharyngitis sicca), even when of several years' standing, as met with in salesmen and others, whose mouths are more or less frequently open, and who, by the nature of their avocations, are exposed to variations of temperature; also in the dryness of the pharynx in cooks, bakers, and others who are constantly breathing a heated atmosphere; also in chronic pharyngitis; in the commencing stage of bronchitis, to induce free secretion; in snuffles, naso-

* Preuss. Vereinzeitung, 1862, 19; quoted by Lewin, op. cit., p. 200.

pharyngeal catarrhs, and the like; in fact in all cases in which the object is to promote secretion or facilitate its detachment and expulsion.

The best mode of administering inhalations of the vapor of chloride of ammonium is, without doubt, in the nascent state; and of all contrivances for the purpose, the apparatus of Lewin (p. 32) is the best. A variety of contrivances have been placed upon the American market to replace this apparatus of Lewin; more compact, in some instances, for purposes of transportation, but possessing no other advantage, and much less simple in their construction. I prefer, in some respects, the arrangement of Lewin's apparatus, as modified by myself,* in which the external air is forced into the apparatus by means of a handball bellows, so that the vapor can be inhaled as it escapes, without subjecting the patient to the effort of aspiration.

One precaution is requisite in the use of these vapors, and that is not to continue them too long at a time, or repeat them too frequently, as they will eventually remove the epithelium from the tongue and make it sore, especially when they are inhaled from a tubular mouth-piece.

CHLOROFORM.

The anæsthetic uses of chloroform do not come under consideration in this volume.

Chloroform is frequently employed for therapeutic purposes in relaxing spasms, alleviating pain, and promoting secretion from the mucous membrane of the res-

* Diseases of the Throat, etc., New York, 1872, p. 276.

piratory passages. Baumgärtner,* one of the first to have made extensive use of inhalation of chloroform for therapeutic purposes, employed it chiefly in pneumonia; but tried it also in bronchial catarrh, emphysema, asthma, whooping-cough, and haemoptysis. It appears to diminish the pain, sense of oppression, and cough, in pneumonia, and thus to contribute greatly to the comfort of the patient. Baumgärtner's results have been confirmed by many observers, some of whom, indeed, have found the inhalation curative in pneumonia.

Dr. Hutawa has reported† the happiest results in pneumonia from the inhalation of half a drachm or a drachm every hour, day and night.

Dr. Malmsten, of Stockholm,‡ claimed to have cured two cases of pneumonia, and one case of capillary bronchitis, by means of chloroform inhalations.

In nervous and spasmodic affections of the respiratory organs the inhalation of chloroform is certainly often beneficial, and it may be resorted to with some degree of confidence in the spasms of whooping-cough, stridulous laryngismus, and spasmodic coughs of almost every nature.

Dr. Fleetwood Churchill§ recommended these inhalations in whooping-cough as controlling the disposition to cough, the whoop, and the like.

* (*Neue Behandlungsweise der Lungenentzündung und anderer Brustkrankheiten, nebst einer Darstellung der Abortionmethode, Mit Beiträgen von Helbing, von Rotleck, Schmidt, etc.* Stuttgart, 1850.) Waldenburg, op. cit., p. 646.

† (*Preuss.-Verein-Zeit.*, 11, 1855.) *Am. Jour. Med. Sci.*, April, 1856, p. 476.

‡ (*Edinb. Med. Jour.*, from *Jour. f. Kinderheilk.*, 1855, Bd. xxiv, p. 435.) *Am. Jour. Med. Sci.*, April, 1856, p. 477.

§ *Edinb. Med. Jour.*, Aug., 1853; *Braithewaite*, 1853, p. 93.

Mr. G. H. Heath reported* that the excessive vomiting in cholera will sometimes be controlled by inhalations of chloroform, when nothing else will succeed ; and that life may in this way be saved.

The inhalation of chloroform has been recommended in spasmodic croup to overcome the spasm. It has also been highly recommended in asthma by various observers, one of the most distinguished among whom† considered it one of the most powerful and speedy remedies in asthma ; one to which he should, perhaps, give the first place of all.

It is also employed to overcome the spasm in angina pectoris, colics, and other painful affections, without pushing the administration to the abolition of sensation or consciousness.

The inhalation of chloroform is often of signal use in the early or forming stage of acute coryza, relaxing the nervous tension and precipitating the eliminative stage of free secretion or diaphoresis. As elsewhere mentioned,‡ I have sometimes found it competent, pushed to anaesthesia, to avert a severe cold in the head, even in cases of intense pain and tension in the brow and cheeks, with distressful nasal dyspnoea. As a matter of course, it is not to be carelessly or promiscuously employed for this purpose ; but in suitable cases, in subjects whom there would be no hesitation in chloroforming for the purpose of performing an operation in surgery, it is admissible in cases of intense suffering ; the more that chloroform administered for the relief of pain is unat-

* The Laneet, Oct. 15th, 1853.

† Salter ; on Asthma. Philada., 1864, p. 135.

‡ Diseases of the Throat, etc. New York, 1872, p. 256.

tended with as much danger as when given to prevent pain.

ETHER.

The anæsthetic uses of ether do not come under consideration in this volume.

Beddoes* mentions that Pearson, of London, recommended inhalation of ether in pulmonic phthisis, in which he had found it subdue the hectic, check the sweats, relieve the dyspnœa, deodorize the sputa, and facilitate expectoration. The vapor of ether was saturated with cicuta leaves, half an ounce of the latter in powder being kept in an ounce of the former for a week; a teaspoonful or two of the impregnated fluid being inhaled at a time, and repeated three times a day or oftener, according to circumstances.† He did not recommend them as curative, but as affording very grateful relief, so that patients will not willingly discontinue their employment, after having once experienced their benefits.

Inhalations of ether, impregnated with squill by the addition of the tineture, are recommended in asthma by the same authority.‡

Scudamore employed inhalations of ether in spasmodic asthma.

Dr. Eberle recommended the inhalation of ethereal vapors in pulmonary affections. He considered them of very great value in relieving dyspnœa.§

* Beddoes and Watt, *Factitious Airs*.

† Morton; *Illustrations of Pulmonary Consumption*, Philada., 1837, p. 246.

‡ Coxe, *on Medical Inhalation*, Philada., 1845.

§ Coxe, *op. cit.*

Dr. James Clarke, of London, recommended the inhalation of ether, or of ether holding some narcotic in solution, as occasionally useful in the dyspnoea of consumption, and he found (opium and) ether afford the most effectual relief in the last stage of the disease, when the oppression of breathing becomes very distressing, especially towards night.*

Baumgärtner† employed ether as well as chloroform in the various affections named in our mention of the latter remedy.

Dr. Physick, of Philadelphia, was in the habit of employing the vapor from equal parts of Hoffman's anodyne and laudanum, in cases of recent catarrhs, in coryza, and obstinate hoarseness; and its value in these cases is attested by Dr. Chapman in his work on Therapeutics.

In the dyspnoea dependent on chronic bronchitis, Prof. Wood considers the inhalation of ether doubly useful, if carefully managed, both by relieving the distressing sensation and favoring mucous secretion.‡

Inhalations of ether have been recommended as almost an abortive in pneumonia; but Skoda states that he has never seen them exercise any modifying influence, even in the earliest stages.

They have been highly recommended in whooping-cough, spasmodic asthma, and in chronic affections of the air-passages generally; and it is not unlikely that much of the benefit arising from the inhalation of ethereal solutions of the balsams is due to the sulphuric ether.

* A Treatise on Pulmonary Consumption. Philada. Ed., 1835, p. 286.

† Op. cit.

‡ Wood's Therapeutics, second edit., vol. ii, p. 697.

Ether, impregnated with musk, eamphor, asafoetida, opium, and the like, is sometimes preferable to pure ether.

Dr. W. Y. Gadberry, of Yazoo City, Mississippi, records* some cases of capillary bronchitis treated effectually with inhalations of ether.

The same gentleman has furnished me with the following notes of the effect of the same treatment in a case of acute bronchitis :

" Early in the winter of 1866-67, the Rev. Mr. B—n left Lexington, Mississippi, for Cincinnati, Ohio, suffering with catarrh, and returned in ten days with a violent attack of bronchitis and diarrhoea. During the first week his fever was high, with a pulse ranging from 110 to 130. He complained of oppression of the chest, dyspnœa, and loss of sleep. After a week's trial with the remedies usually adopted in such cases, I became alarmed for the safety of my patient, and determined to use inhalations of sulphuric ether. By it the dyspnœa was immediately relieved, sleep became natural and refreshing, his harassing cough gradually subsided, and he soon recovered. He took it at intervals, *pro re nata*."

Dr. Gadberry informed me that he had asked this patient his opinion of the efficacy of the ether in his case, some months after the treatment, and he had been assured by him that it had given decided and permanent relief.

In a letter to Dr. Gadberry, from Dr. W. H. Williams, of Lexington, Kentucky, the latter gentleman writes under date of April 15th, 1867 :

" During the spring of 1866, I was the subject of severe bronchial catarrh, which persisted for many weeks, resisting the ordinary course of treatment prescribed by adopted authorities, when, at your suggestion, I began the use of ethereal inhalations, the disease at this time having assumed a gravity well calculated to arouse my suspicion of approaching tuberculosis. I first used

* Nashville Journal of Medicine and Surgery, October, 1866.

sulphuric ether, and it served well the purpose of relieving the frequent paroxysms of dyspnoea, which, though not severe, were extremely annoying. Subsequently I adopted the use of equal parts of ether and tar, and with more gratifying results than I had experienced from the use of ether alone.

"The combination seems to promote a free and easy, yet not a copious expectoration, but on the contrary exhibits a decided tendency to overcome the hypersecretion. This, perhaps, is due to a sedative and antiphlogistic influence exerted by the tar-vapor upon the inflamed mucous membrane. I pursued this course for some weeks, to my entire relief."

Dr. Samuel W. Francis, of Newport, Rhode Island, has informed* me that he has employed inhalations of ether for a bad sore throat, to which he is subject, and feels confident that the inhalation not only alleviated the symptoms, but cured the sore throat; and he has formed the opinion that we have a valuable remedy by this means, in the treatment of bronchitis.

The inhalation of sulphuric ether has been recommended from various sources as a valuable remedy in cases of hysterical or nervous aphonia. I have myself, on several occasions, been able to restore the voice in cases of aphonia in this way, but most of the cases referred to occurred in military practice, and I have no reason to believe that they were not those of malingering in every instance. It was curious to notice in some of the cases, after the subjects had learned the object of placing them under an anaesthetic influence, how well they could control themselves while going under the influence of the ether, not a sound escaping them until the moment of unconsciousness; but, oblivion having once ensued, the effect in coming to was not anticipated, or if anticipated, was forgotten under the anaesthetic condi-

* Letter of March 5th, 1867.

tion, and the intoxication would be evinced by the usual clamors, when a sudden restoration of consciousness would announce to them, with a moral shock, the cure of their aphonia.

I have, however, succeeded in restoring the voice in cases of so-called nervous aphonia, by the injection of sulphuric ether into the larynx; but here the result was due to the local stimulus, rather than to the therapeutic effect of the ether.

Dr. F. D. Lente, of Cold Springs, New York, records* a case of hysterical aphonia cured by the inhalation of sulphuric ether.

"This was an unmarried female, at. 40, who had been an invalid for several years. Early in 1860 she lost her voice so that she could not articulate above a whisper. In December of that year she was placed under the influence of sulphuric ether for the reduction of a strangulated femoral hernia, and twice, on recovering from the anaesthetic influence, the patient expressed her belief that she articulated with less effort, although she still spoke in whispers. Brought a third time under the influence of the ether, preparatory to the operation, certain attendant circumstances kept her under the influence of the ether for two hours, and as soon as she had fully recovered from its effect she exclaimed aloud, 'Doctor, I can speak!' and her voice remained permanent up to the date of the report."

Dr. Lente instances a case reported a short time previously, in which a carman of London recovered the use of his voice after a deprivation of eight months, while under the influence of chloroform, for the purpose of overcoming some rigidity about the muscles of his jaw.

The late Dr. L. Nordmann, of this city, wrote me under date of April 6th, 1867, that at Haddington

* Am. Med. Times, April 6th, 1861, p. 224.

U. S. A. General Hospital, he had under his charge, in 1864, three cases of complete aphonia in United States soldiers, young men otherwise healthy. These men were not considered malingeringers by himself nor by his colleagues. They each had made a similar statement, that loss of voice followed a severe cough contracted during prolonged exposure to wet and cold while on duty, some three months previous to his seeing them. Having heard of a case of aphonia successfully treated in Baltimore by inhalations of sulphuric ether, Dr. Nordmann determined to try the effect of the inhalation of ether on these cases, and as the effects of the anaesthetic passed off, each, to his great surprise, had recovered the proper use of his voice.

Dr. James H. Hutchinson, of Philadelphia, has reported a case of loss (hysterical) of speech and hearing successfully treated by the inhalation of ether.*

The Montreal *Gazette médicale* publishes from *L'Abbeille médicale* the report of two cases of diphtheritic angina, or false membranous croup, treated with success by inhalations of ether, under charge of Dr. M. Besson:

"The first patient was a girl six years of age, who presented the following symptoms: Swelling of the submaxillary glands, puffed face, pulse slightly accelerated, pain in the throat, difficulty in swallowing, mucous membrane of fauces engorged and reddened, tonsils strongly tumefied, and presenting several patches of the pellicular exudation which characterizes diphtheritic angina. Voice gone; cough dry, choking, and croupy. Respiration short, accelerated, and labored. The patient was at first treated in the usual manner,—by vomits of tartar-emetic and ipecacuanha, etc., chlorate of potassa, mercurial frictions around the neck,—with no effect, however, except the expulsion of some membranous shreds and patches. As a *dernier ressort*, Dr. B. thinking it unadvisable

* Am. Jour. Med. Sci., April, 1861, p 412.

to resort to tracheotomy, inhalations of ether were employed. The effect was an attack of suffocation, accompanied by a violent respiratory struggle, lasting nearly a minute, during which a false membrane, over six centimetres in length, and three millimetres in thickness, very dense, like a piece of parchment, was expelled. The effects of this paroxysm gradually subsided, and the patient soon went into a calm sleep. After about eight hours the symptoms recurred, and again recourse was had to the ether fumigations, resulting in further expulsion of false membranous exudation. Calm and sleep again supervened, the croupy symptoms yielded, and in a few days complete recovery had taken place.

"The second patient was a little boy, five years of age, who was attacked with diphtheritic angina. Vomits of sulphate of copper, etc., had been used, followed by the expulsion of some false membrane, but still the symptoms became aggravated. There was complete aphonia, tonsils tumefied, and covered with whitish patches; cough insonorous and choking; successive dyspnœa; convulsive movements of the expiratory muscles; quick, sibilant inspiration; face congested; eyes injected; jugulars distended; extreme anxiety, convulsive agitation, and intense fever. In short, the patient was in the midst of these terrible paroxysms, which have hardly any remission, and which announce that the final symptoms of asphyxia are near at hand. In this condition the patient was made to inhale, in the space of several minutes, about five drachms of vaporized ether, and soon afterwards, in the midst of the violent efforts of a veritable strangulation, he expelled, enveloped in thready mucosities, a false membrane, seven to eight centimetres long, two centimetres in its greatest circumference, and very dense. In half an hour the symptoms of amelioration had become so decided that the disease was thought to be broken, and during the forepart of the night the little patient rested quietly. Towards midnight the dyspnœa and the paroxysms became again urgent and violent, so that the patient himself cried for the use of the ether. This second fumigation produced the expulsion of several pieces of false membrane, rolled upon themselves, but smaller than the previous one. Again, subsidence of the croupy symptoms, and their occasional reoccurrence during the next two days, when the ether was again applied. The patient finally recovered."

The evaporation of the ether in these cases was ac-

complished by very simple means. Placing a bottle containing the ether, and terminating in an extemporized tube, into a bowl of water at 40° Cent., the ether fumes were thus carried from the tube into the air-passages with the air of inspiration.*

Dr. R. R. Livingston, of Plattsmouth, Nebraska, communicates† the particulars of a case of laryngitis with exudation of lymph, treated with inhalations of sulphuric ether :

"On the 4th of January, Dr. L. was called to a little girl, at two years, the messenger informing him that the patient had croup, and was dying. Previous to his arrival the mother had administered a full dose of syrup of squills, and he found the patient vomiting and purging freely. Pulse 150; tongue slightly coated, somewhat swollen, and red; fauces red, with an engorged appearance; tonsils slightly swollen; considerable tenderness over the larynx; eyes watery; breathing slightly stridulous, the mother stating that previous to emesis it was very labored, or, as she expressed it, 'the child was choking;' countenance expressive of great anxiety; and though no coughing occurred at the time of the doctor's visit, he was informed that she had coughed repeatedly with a ringing, croupy cough.

"Inhalations of lime-water were directed, as hot as could be borne by the child; also one of the following powders every two hours, viz.: R. Hyd. chlor. mit., gr. x; antim. et pot. tart., gr. j; ammoniae hydrochlor, $\frac{3}{2}$ j; M. ft. chart. No. xii.‡ The mother of the child was instructed to keep a large, open kettle of water boiling on the stove, for the purpose of moistening the atmosphere.

"About midnight Dr. L. received a most urgent request to visit the child immediately, as she was suffocating. Before entering the chamber of the invalid, he was struck with the loud

* Med. and Surg. Reporter, Philada., April 25th, 1866.

† Am. Jour. Med. Sci., April, 1867, p. 376.

‡ Prescriptions converting calomel into corrosive sublimate should be avoided theoretically, though not infrequently found apparently harmless in actual practice.

wheezing noise of her respiration, and the peculiar loud ringing cough. There was great dyspnœa; respiration performed with difficulty; nostrils dilated; muscles of chest and neck violently exerted; lips livid, and head thrown backwards, with great restlessness, and a slightly cyanosed appearance of the countenance. On inquiry, he was informed that the lime-water inhalations had afforded temporary relief, but that each time they were left off the difficulty of breathing recurred in a short time.

"The parents were informed of the perilous condition of their child, for whose recovery tracheotomy appeared to offer the only hope, though with very little encouragement. At this moment, remembering the suggestion of Dr. Blaek and Dr. Gadberry, he proceeded to administer some of Squibb's ether by inhalation, according to the directions of Dr. Lente, as reported by Dr. Paekard, in the *Am. Jour. Med. Sci.*, for January, 1866, premising the inhalation by the internal administration of half a teaspoonful, which, as anticipated, was swallowed with difficulty, and caused a severe paroxysm of coughing.

"In precisely eight minutes from the time the patient commenced the inhalation, the abnormal muscular exertion ceased; a general relaxation took place; the pulse fell to 100, and the peculiar 'flip' sound of partially detached membrane was distinctly heard during expiration; the loud wheezing noise of the breathing abated, and in thirteen minutes the child was sleeping in comparative ease. In about ten minutes more she coughed, not with the loud, ringing, metallic sound so peculiar to this affection, but with the moist râle which every practitioner hails as the harbinger of success in the treatment of this dreadful malady. The coughing was followed by efforts at vomiting, and numerous portions of membrane were discharged, the edges having a whitish, and the centres a grayish appearance; they were oblong in shape, from an eighth to three-fourths of an inch in length, and from half a line to a line in thickness. A few times more, at short intervals, coughing occurred, followed by emesis and the expulsion of additional portions of membrane. The vomiting now ceased, and the child slept almost naturally, the respiration being normal. Her sleep was frequently disturbed by short fits of coughing; but the intervals of rest increased in duration, and no more membrane was expelled, though it was evident that she occasionally swallowed portions without completely awaking. At 4 o'clock the

child was out of danger; at 10 A. M. awake and playful. The recovery was entire."

In commenting on this case, Dr. Livingston acknowledges that the previous exhibition of the powders, and the inhalations of the nebulized lime-water, may render it doubtful whether the recovery was entirely due to the inhalation of the ether; and, suggesting that the spray of the lime-water is in great measure carbonated by inhalation and thus rendered inoperative, he attributes the temporary relief afforded by its administration to the warm moisture of the water. But as there was no evidence of permanent relief until the administration of ether by inhalation, and the favorable effect of the latter was rapidly produced under his direct observation, he has no hesitancy whatever in ascribing the recovery to the ether.

Dr. W. Y. Gadberry, of Yazoo City, Mississippi, has furnished me the following notes of a case of croup treated by inhalations of sulphuric ether:

"On the night of the 15th of April, 1867, I was called, in the absence of the attending physician, to see a child of Mr. M—, æt. eight months. When I arrived the child was in imminent danger of dying from nonplastic croup. It had been relieved on the night previous with emetics of alum and lobelia, and cold applications to the throat. The fever, however, continued up to the time of my visit. I ordered an alum emetic, which acted promptly; applied turpentine and hot flannels to the throat, and a snuff plaster to the chest. In the course of half an hour the symptoms improved some little, but not enough to justify my departure, or any assurance of permanent relief. I then resorted to inhalations of sulphuric ether, which gave complete relief in five minutes to all the difficulty of respiration; nor did it return any more. To relieve the febrile excitement I directed hyd. eum creta, to be repeated until it acted on the bowels."

My own experience with inhalations of ether in croup,

limited, however, to a few experimental attempts, has not been confirmative of the successes reported by others. Very little has been heard of this method of treatment since the first edition of this volume.

A combination of ether, sixty parts; chloroform, thirty parts, and turpentine, one part, has been recommended in whooping-cough by Dr. Wild,* who claims that he can cure every case within eight days, by confining the patient to his room, and making him, at every access of coughing, place before his mouth a small piece of cloth, folded several times, and wet with a teaspoonful of the solution.

NITRITE OF AMYL.

The introduction of nitrite of amyl into therapeutics is due to Dr. Brunton, who first employed it in angina peitoris;† in which complaint he found it more efficacious than any other remedy. His experience has been confirmed by Anstie, Talfourd Jones, and others, in Great Britain, and by S. Weir Mitchell and others, in the United States, who have also found it useful in relieving the paroxysmal dyspnœa of asthma, in neuralgias, especially those of the fifth pair of nerves, and in abating the paroxysms of convulsions in epilepsy,‡ and in tetanus.§ I have occasionally resorted to it in spasm of the larynx, whether due to disease or excited by the direct application of remedial agents, and have found it efficacious in relaxing the spasm; and I can repeat the observation with

* American Practitioner, May, 1875.

† The Lancet, 1867, 11, p. 97.

‡ S. Weir Mitchell, Philada. Med. Times, April, 1872; Trans. Coll. Phys., Philada., 1875, p. 107.

§ See, particularly, Forbes, Trans. Coll. Phys., Philada., 1875, p. 121.

regard to paroxysms of nervous asthma. It has been recommended in whooping-cough, and in spasm of the stomach. In fact, it appears to be a relaxer of spasm generally.

It is usually administered by pouring from two to ten drops upon a handkerchief, according to the susceptibility of the individual,—a susceptibility which decreases with its repeated use,—and inhaling the vapor until the characteristic effect is produced, which is visible in from thirty to sixty seconds, and is manifested in suffusion of the face and neck, with varying increase in the frequency and force of the pulse, as exhibited in the carotids and the action of the heart. Dr. Brunton's investigations show that it relaxes the arterial system generally; and this is attributed to partial paralysis of the sympathetic ganglia and the motor nerves. When inhaled under unconsciousness, it exhibits a specific action on the motor centres of the mouth, manifested by yawning, etc.*

The flushing of the face induced by this agent suggested its use in facial neuralgia associated with anaemia;† and experience seems to indicate that larger doses are borne in anaemic patients than in others.

The use of this agent requires caution, though it does not appear to be as dangerous a remedy as it was supposed to be in the earlier essays of its therapeutic application.

Dr. Rufus R. Hinton‡ reports a few cases of the successful use of inhalations of the nitrite in hysterical

* J. Crichton Browne, *The Practitioner*, Sept., 1874, p. 179.

† Dr. Geo. H. Evans, *ibid.*, Sept., 1875, p. 178.

‡ *Phila. Med. Times*, July 31st, 1875, p. 694.

convulsions, the cold stage of intermittents, and chloroform-narcosis.

Dr. Croehley Clapham recommends the use of this agent in sea-sickness, after considerable experience of its utility.* He poured three drops on a handkerchief, and held it close to the patient's nose, so as to impede too free admixture of atmospheric air. In 121 cases out of 124 there was no return of vomiting after the administration of the nitrite, and its use was only unsatisfactory in the remainder, in so far that they required a further dose or two of the remedy.

Inhalation of nitrite of amyl was suggested by Dr. F. A. Burrall, of New York,† in threatened syncope from chloroform; and quite recently Mr. C. Bader, of London,‡ has reported a few cases of the kind in which the inhalation of the nitrite appears to have accomplished the expected result.

BALSAMIC VAPORS.

The custom of sending patients with pulmonary complaints to localities where they might constantly breathe the balsamic atmosphere produced by the vegetations of aromatic plants, is of very old origin, dating at least from Rhazes in the ninth century; and the direct use of balsamic inhalations is attributed to Galen, Aselepiades, and Dioseorides.

In the middle of the seventeenth century Dr. Bennet, of London, employed artificial balsamic atmospheres by

* *The Lancet*, Aug. 21st, 1875, p. 276.

† (*N. Y. Med. Gaz.*, June 11th, 1870); *Am. Jour. Med. Sci.*, July, 1875, p. 233.

‡ (*The Lancet*, May 8th, 1875), *ibid.*

fumigations of frankineense, styrax, ammoniaeum, and turpentine, with coltsfoot, cinnamon, and the like, in powder, or made into troches and burned upon coals. He also employed the vapors evolved by pouring boiling water upon various mixtures of herbs.*

These vapors were much used by Mead and others, and are recommended, among other inhalations, as promotive of secretion, by Dr. Tweedie, in his treatise on Diseases of the Respiratory Organs.

Balsamic inhalations at one time attracted a great deal of attention in continental Europe. They were recommended in the treatment of chronic pulmonary catarrhs, and obstinate cases of chronic laryngitis, especially when connected with ulceration, by Delpit, Rullier, Maygrier, Martin Solon, and many others; and by none more strongly than by Troussseau and Pidoux. Troussseau and Pidoux preferred to throw some of the balsam upon live coals, rather than to pour boiling water upon some of the material in an inhaler; because, by the former method, the apartment becomes filled with the vapor, and the patient can remain for whole days in an atmosphere thus impregnated. They state that chronic catarrhs have been cured in this manner, after failure with the same remedies used internally.

These inhalations were found valuable in phthisis, as a means of conserving strength, and thus prolonging life. The balsams most constantly employed were benzoin and balsam of Tolu, the latter more frequently; and the balsam of Peru was also occasionally employed in the same way.

Inhalation of an ethereal solution of Tolu has been

* Copland's Dict.

successfully employed by M. Roziere in cases of bronchial catarrh, loss of voice, and chronic affections of the chest generally. His plan is to mix twenty grammes of the balsam with sixty grammes of sulphuric ether; the mixture to be placed in a wide-mouthed bottle, which the patient holds, uncorked, to his nose for two or three minutes every half hour.

As, however, the inhalation of sulphuric ether alone, as mentioned previously, is very highly recommended in these very affections, it is not improbable that much of the beneficial effect of the ethereal solution of Tolu is attributable to the menstruum.

Benzoin, in the form of the compound tincture, is an excellent sedative in many catarrhal inflammatory lesions of the pharynx and upper air-passages, whether primary or supervening as exacerbations of chronic conditions. A drachm of the tincture may be thrown upon a pint of hot water, and inhaled for from five to ten minutes every few hours.

To employ the balsams with the ordinary inhaler, boiling water may be poured upon one or two drachms of the drug.

The balsam of copaiba was much used in inhalation by Dr. Edward J. Coxe,* of Baltimore, in the treatment of chronic laryngeal and bronchial affections; and deserves more attention than has hitherto been paid to it.

Lewin† reproduces an interesting account of the method of inhalation pursued by the Persians, as narrated by Dr. Polak, physician to the Shah. This consists in smoking the fumes of certain medicinal agents

* Op. cit.

† Op. cit., p. 209, from the Allg. med. Central Zeitung, 1863, No. 23.

through their narghilè, a smoking apparatus, by means of which the smoke passes through a vessel containing cold water, before it reaches the mouth. The material to be employed medicinally is mixed with their smoking tobaceo, which is made into moistened masses and inserted into the plaster bowl of the narghilè, and then covered with burning coals. The material is slowly consumed, and the smoke in passing through the cold water receptacle is not only cooled, but also deprived of a portion of its narcotic or other properties.

In cases of chronic catarrh and bronchitis, Dr. Polak employed gum ammoniac, gum galbanum, etc.; in spasmodic and hysterical affections, assafœtida; in ischias, turpentine with pistachia lentiscus, or mastic, with good results, or at least without injurious effect. In addition, they could employ quinine, salicine, even nareotine and digitalis; and many mineral substances, as borax, sal ammoniac, and the like.

By smoking the tobaceo, a condition of relaxation can be induced, advantage of which may be taken, the same as the narcosis from chloroform, for the reduction of luxations, the reposition of hernias, etc. The plant tombak employed by the Orientals, is one of the Nicotianæ, and very similar to our own tobaceo; it has a red leaf, grows favorably in sandy soils, etc., etc.

RESINOUS VAPORS OF THE CONIFERÆ.

Dr. W. W. Ireland,* had already made the observation that in pine forests the quantity of ozone in the air was increased by their resinous emanations, which contained, if not ozone itself, at least a substance possessing

* Edinburgh Medical Journal, Feb. 1864; British and Foreign Med.-Chir. Review, July, 1864, p. 250.

many of its properties. He records some practical observations made at a little town called Die, in the south of France, on the therapeutic effect of resinous vapors. This kind of treatment was in popular use among the mountains of Dauphiné for more than a century, and was discovered by accident. Some laborers were cutting wood for preparing pitch, when one of them was suddenly seized with acute rheumatism in the legs, which disabled him from the more active work, but allowed him to arrange the cut wood in the furnace. After working a little time at this employment, which exposed him to the resinous vapors from the wood, he felt his complaint gradually disappearing; and the cure thus effected became known among the peasantry, and subsequently attracted more particular attention.

Dr. Chevandier, finding that the peasants suffering from rheumatism exposed themselves to the vapors of a pitch furnace, and thus became cured of their complaints, examined the subject in a scientific manner. He found that the peasants had been in the habit of sitting in the furnace at a heat of nearly 190° Fahrenheit, and his own experience showed that in an atmosphere saturated with turpentine vapors, this very high temperature was not only tolerable, but pleasant; and he himself entered the furnace to study its physiological effects. He found that the skin perspired freely, the pulse rose, and his sensations were agreeable.

Since these experiments were made, some baths have been used at Die, constructed on the same principle as the pitch furnace. They resemble large baking-ovens, the fire being below; the resinous layers of pine wood are strewed upon the floor, and the patient sits upon a bench, wrapped in a porous covering of wool.

The temperature to which the patients are exposed is generally from 140° to 158° Fahr., and they remain in the atmosphere from fifteen to twenty minutes. The sensations of the patients are agreeable, the perspiration is abundant, the pulse rises from twelve to fifteen beats, and the respiration is accelerated at first. After the proper period has expired, the patient goes to bed, where he remains an hour or two.

The diseases treated by this plan are: rheumatism in all its forms; inflammation of mucous surfaces, as chronic bronchitis and laryngitis; neuralgia; glandular enlargements; and constitutional syphilis. Nine-tenths of the patients who resort to Die suffer from rheumatism, the muscular form yielding more readily than any other, but articular rheumatism yielding more slowly. Next to rheumatism, chronic bronchitis appears to be the malady most benefited by this treatment, probably from the effects of the vapor on the diseased mucous membrane. Several cases of phthisis are also said to have been successfully treated by courses of twenty baths; but most of the cases were in the first stage.

Peectoral complaints, it is said, never occur primarily among those who work in turpentine, and in the south of France it is known that these maladies, and rheumatism likewise, are comparatively rare among the inhabitants of districts covered by pine forests; and hence it would appear that the resinous vapors possess some important therapeutic properties in these affections.

Dr. Ireland suggests that the beneficial effects may be due to the influence of ozone or ant ozone upon the blood. Hence, fumigations of the resinous layers of fresh pine wood, or oil of turpentine, may be beneficial in phthisis.

The patient may live in a room or conservatory filled with saplings of pine, and thus reap similar benefit.

Baths, like those used at Die, have been attempted in other places, as at Grenoble, Valence, and near Vaucluse, but the wood the inhabitants employ is said not to be the same; and Dr. Ireland recommends patients laboring under obstinate rheumatism or bronchitis to go to Die, which is reached by a diligence, starting from the railway station at Valence. Die is a small town, situated in a beautiful valley among the Alps of Dauphiné, the lofty peaks of which guard it from the mistral, while its elevated situation saves it from the scorching heat of the summer of the South.

Inhalations of the vapors of resin have been employed under the same circumstances as the vapors of tar, turpentine, creasote, and the like; and the well-known effect of such inhalations has prompted the practice, which is of very ancient origin, of sending patients affected with phthisis and other chronic pulmonary affections, for temporary or permanent residence, to regions in which pine forests abound.

The fumes from burning undressed wool have also been recommended in cases of chronic laryngitis and bronchitis, and they have likewise, it is said, proved advantageous in phthisis.

It may be remarked in connection, that the assertion has been made, by Simpson and others, that young persons employed in wool factories are exempt from phthisis, in consequence of their constant exposure to the inhalation of oil, which is used in large quantities in such factories.

TAR.

The inhalation of vapors of tar was recommended in

pectoral complaints by Dr. Rush, of Philadelphia, in 1787. The plan pursued by this distinguished physician was to boil together equal parts of tar, bran, and water.* Beddoes also† records a case communicated to him, in which exposure to the emanations from tar in a warehouse was of great benefit in a case of confirmed phthisis. It is to Sir Alexander Crichton,‡ physician to the Empress of Russia, however, to whom the profession is chiefly indebted for a recognition of the therapeutic uses of this remedy, the discovery of which he attributes to accident, and which he was induced to try by a conjecture of Mudge, that the salutary effect of sea-voyages is greatly assisted by the inhalation of an atmosphere impregnated with the volatile parts of the resinous and terebinthinate substances used aboard sailing vessels.§

The tar recommended by Sir Alexander Crichton is that used for the cordage of ships, to every pound of which he advises the addition of half an ounce of the subcarbonate of potassa, in order to neutralize the pyroligneous acid.||

He placed the vessel containing the tar over a spirit-

* Morton, Illustrations of Pulmonary Consumption, Philada., 1837, p. 245.

† Considerations on the Factitious Airs, etc.

‡ An Account of some Experiments made with the Vapor of Boiling Tar, in the Cure of Pulmonary Consumption; Petersburg and London, 1817. Practical Observations on the Treatment and Cure of Several Varieties of Pulmonary Consumption, and on the Effects of the Vapor of Boiling Tar in that Disease; London, 1823.

§ Clarke, op. cit., p. 274.

|| Prof. Chapman, of Philadelphia, found benefit from the fumes of concentrated pyroligneous acid in foul ulcerations of the throat and nostrils. (Therapeutics, vol. ii, p. 36.)

lamp, taking care that it should boil slowly and not burn; the tar being renewed every three hours, so as to keep the apartment impregnated with the vapor night and day. The vessel must be cleansed daily to prevent the incineration and decomposition of the residuum, the effect of which is irritating.

These fumigations did not constitute the entire treatment; other remedies being employed as deemed advisable.

Crichton often found it useful to evolve the vapor of water at the same time; to which end he diluted the tar with more or less spring water. As long as the tar remains fluid, it may be used again and again; but as soon as it becomes viscid it must be renewed. The first effect of these inhalations is slight headache, some little shortness of breath, and slight increase of expectoration; the latter being considered a favorable indication for continuance of the treatment. Increased dryness of secretion, on the other hand, is a contraindication. As soon, however, as there is any evidence of inflammatory action from the fumigation, the treatment is to be suspended for obvious reasons.

Crichton recommended these inhalations in pulmonary phthisis, even in its colliquative stage, in the first stage of laryngeal phthisis, in chronic bronchitis, and in pulmonic blennorrhœa.

Dr. Maekintosh* recommended the inhalation of the vapors of tar in chronic uncomplicated bronchitis. Dr. Eberle† recommended the fumes of tar in whooping-cough. Dr. M. Baillie, of London, attests the value of inhalations of vapors of boiling tar and vinegar, in ton-

* Practice of Physic.

† Mat. Med., Philada.

sillitis, and similar affections. Dr. Morton,* of Philadelphia, employed inhalation of tar vapor extensively as a palliative in consumption, and knew no treatment that could vie with it in chronic catarrh, especially when attended with ulceration of the mucous membrane; and he states that the same remark will apply to those morbid conditions left by pneumonia and pleurisy, especially when accompanied with purulent expectoration and dyspnoea.

Prof. Wood† has witnessed the happiest effects from the vapors of tar, when continued for months, in very threatening chronic pulmonary disease.

I have frequently seen benefit from the vapors of tar in cases of advanced phthisis, and in chronic bronchitis, where, if it has no other local influence, it at least reduces the irritability of the mucous membrane, checks hypersecretion to some extent, and facilitates expectoration; thus conserving the powers of the patient. In recent inflammations, and in the hectic fever of phthisis, its use requires caution, as it has been said to induce congestion, and may thus give rise to haemorrhage or severe inflammation. Similar caution is to be observed in cases with irritable cough.

Dr. Somerville Oliver‡ has suggested the use of fresh oakum, as a substitute for tar, the oakum being introduced into a sort of net or respirator.

The use of tar vapors in phthisis deserves to be fully and systematically studied, so that safe indications may be laid down as to the character of cases to which it is most applicable. The slow torpid cases of chronic phthisis,

* Op. cit., p. 245.

† Therapeutics, etc., 2d ed., vol. i, p. 78

‡ An Oakum Respirator; *The Lancet*, July 8th, 1871, p. 45.

in which there is little disposition to acute exacerbation, seem to be those in which most benefit is to be expected. It should be employed cautiously, and in but moderate quantity at first, under all other circumstances; and increased gradually if it acts well, or if it does not act injuriously.

An iron sauceman upon the fire or over a gas flame, with a tin cover terminating in an elbow of piping, such as is used for rain spouts, forms an apparatus for evolving tar vapor, which can readily be arranged by a tinsmith at short notice; the efficacy of which I have availed myself of in my own practice. The tar (prepared tar is the best) is mixed with water until it is soft, and a few ounces are placed in the pot, which is then filled with water and covered. The fumes, as they arise with the warm vapor of water, are directed into the room by the elbow of piping, which should be long enough to give sufficient direction to the vapor.

While this volume was in press, Dr. William K. Dunton, of Germantown, called my attention to a very simple and inexpensive apparatus for the direct inhalation of tar vapor, long used by physicians in that section of our city, though he was unable to inform me by whom it was devised. It consists of a tin cup of the capacity of a pint, in which warm water is placed; a tin reservoir fits tightly into the cup, but does not reach to within one-third of the bottom; into this reservoir a small quantity of tar is placed; and this reservoir is covered with a tight-fitting lid, with two holes for the entrance of air, and a central opening, from which a rectangular tube rises, terminating in a funnel-shaped orifice, so compressed from side to side at its upper portion that it fits very nicely over the mouth and nose.

The cup is placed upon the fire until the vapor is given off, and is then held by the patient in front of his mouth and nose. The apparatus can likewise be used for the generation of other vapors.

OIL OF TURPENTINE.

Vapors from oil of turpentine were first used therapeutically by Sir Alexander Crichton. It has been supposed that much of the value of external applications of oil of turpentine in pectoral complaints is due to inhalation of the vapor. Whooping-cough, asthma, bronchitis, and even croup have been treated satisfactorily in this manner.

Stokes* has expressed his disapproval of inhalations of turpentine in the strongest of terms, and states that he has known several cases where a chronic bronchitis was converted into an acute, and, as might be expected, fatal pneumonia, by the use of the turpentine inhalations. At the same time this author recommends in the warmest of terms† the daily sponging of a large surface of the chest with a liniment composed of turpentine and acetic acid, not only in bronchitis, but even in confirmed phthisis, for the very reason, chiefly, that he believes that the ingredients are absorbed by the surface, so as to act on the mucous membrane as distinct stimuli. The formula for this famous Stokes's liniment, which, more or less modified, I have often found of use in chronic bronchitis, and in mild asthma,—chiefly, I believe, from inhalation of the vapor which emanates from the patient's body, especially at night in bed,—is as follows:

* Diseases of the Chest, Philada. Ed., 1837, p. 81.

† Op. cit., p. 82.

Spts. terebinth., f $\ddot{\text{s}}$ iij; acid. acet., f $\ddot{\text{s}}$ ss.; vitell. ovi, No. j; aq. rosar., f $\ddot{\text{s}}$ iiss.; ol. limonis, f $\ddot{\text{s}}$ j. M. It is similar to the famous liniment of St. John Long, whieh, however, eontained pyroligneous acid instead of the acetie acid.

Ramadge* employed turpentine among other inhalations; but he attributed most of the benefit derived from the inhalation to the concurrent gymnastic exercise of the chest and its contents.

Snow† found turpentine inhalations useful in alleviating the cough of phthisis.

The chief remedial employment of vapors of turpentine, however, has been in eases of pulmonary gangrene, to correct fetor and stimulate the cavities. They have likewise found use in putrid bronchitis. Their utilization in this direction is chiefly due to Prof. Skoda, who has repeatedly treated gangrene of the lung successfully by turpentine inhalations. His plan is as follows: The essence of turpentine is poured upon boiling water, and the patient is direeted to inhale the vapor arising therefrom for fifteen minutes every two hours. Sulphate of quinia is also administered in the usual doses. Four eases are reported.‡

"The first case was that of a servant affected with limited gangrene of the superior lobe of the right lung. After six weeks of this treatment, it became impossible to detect either infiltration or gangrene of the organ. On the contrary, the respiratory murmur had returned over the whole region. Three months afterwards the patient was seen in good health.

"In the second ease, an innkeeper, of mature age and strong constitution, became the subject of a gangrenous cavity in the lower

* Consumption Curable, etc., London, 1838.

† London Med. Jour., Feb. 1851.

‡ Medical Times and Gazette, April 15th, 1853; and Zeitschr. für K. K. Geselsch. der Aerzte zu Wien., 1853, t. ix, p. 445.

lobe of the right lung, consequent upon disease commencing March 11th, 1852. On March 21st the patient began with the inhalations of the vapor of turpentine; he continued, without repugnance, for five or ten minutes every two hours, taking, at the same time, the usual doses of quinia. At the end of three weeks the expectoration, which had been extremely abundant (a pint and a half daily), became reduced to a quarter of a pint. The inspirations had been employed four times a day. At the end of six weeks the patient could quit his bed. His strength was returning, the appetite was improving, and his general aspect was favorable; but the expectoration continued to be fetid from time to time, and always sanious. The right side of the chest was painful and respiration was labored, but the air entered the circumference of the lower lobe; the respiration being uncertain, and accompanied by feeble râles and sibilancee. The patient went into the country, where he continued the turpentine inspirations twice a day up to the middle of July, by which time both cough and expectoration had entirely disappeared. In the month of December, 1852, he came to M. Skoda for a certificate of health. There was no pain, nor oppression, nor cough. He had recovered his *embonpoint* and his strength; there was no retraction of the thorax; vesicular respiration was audible everywhere.

"In the third case it was not in the Professor's power to persist in the treatment.

"The fourth case was still under treatment. A butcher, of strong constitution, had a gangrenous cavity in the inferior lobe of the left lung. He fell ill about the end of May, 1852. The inspirations of turpentine were commenced June 4th. At the end of a week the fetid expectoration, which daily equalled two pints, had entirely disappeared, and the patient considered himself well, because the pain and the oppression in breathing had diminished, the appetite had returned, and the sleep had become tranquil. He therefore left off inhaling the turpentine, which was extremely disagreeable to him. On June 19th there came on a severe shivering fit, with cough and dyspnœa; and during the following night the patient expectorated several pints of extremely fetid sanies of dirty-brown color. The inspirations were recommenced, but the patient used them as little as possible, on account of the irritation which they produced in the air-passages. In eight days the quantity of matter brought up had greatly diminished, and the pulse was normal; but there was pain in the chest. The patient lay im-

movable upon his back in a state of great weakness and prostration; there was no appetite. The lower lobe of the left lung was impervious to air. The inspirations were again suspended, but again recommenced on account of recurrence of the bad symptoms, the disagreeable odor of the turpentine being partly rectified by a few drops of the essence of rose. About the middle of October he was able to go into the country, having recovered strength sufficient to leave his bed; nevertheless, there remained a sense of oppression and pain under the left scapula. At the end of January he considered himself well. There was a sudden expectoration of two ounces of blood, after a slight fit of coughing, on February 10th, probably proceeding from the callous walls of a former gangrenous cavity; but there were no signs of further infiltration, and the case seemed likely to terminate well."*

Since this period the inhalation of vapors of turpentine has been generally adopted as the best method of treating pulmonary gangrene.

Skoda subsequently employed this treatment successfully, not only in pulmonary gangrene, but also in tracheal and laryngeal catarrh, in paralytic aphonia, and in pulmonic phthisis.†

These inhalations have been recommended by Niemeyer in chronic pulmonic catarrh with emphysema.

They have also been recommended in whooping-cough,‡ in which disease they diminish the intensity of the paroxysm, rather than shorten the duration of the malady or the frequency of the cough.

Beigel has extolled them in catarrh.§

Vapors of turpentine are said to be prophylactic

* Ranking's Abstract, 1854, vol. 18, p. 69; Am. Jour. Med. Sci., Oct. 1854, p. 527.

† Allg. Wien. med. Ztg., 1862, Nos. 16, 24, 26, 29, 31.

‡ Jahrb. f. Kinderheilk., 1860, p. 255; Schmidt's Jahrb., 1866, Bd. 130, p. 63.

§ The Lancet, 1867, p. 512.

against poisoning in the manufacture of phosphoric matches.*

Traube, who frequently employed these inhalations successfully, cautions against exciting inflammations in their use.†

I have found them very useful in some cases of chronic bronchitis, and in the chronic laryngitis of phthisis.

The vapors of oil of turpentine may be evolved by putting from twenty drops to a drachm upon an ounce of water and applying heat; or, as I have frequently done, a drachm may be rubbed up in three or more ounces of water with half a drachm of carbonate of magnesium, and a drachm or more of the mixture be thrown upon hot water.

OILS OF PINE.

The oils of pine are often substituted for the oil of turpentine, on account of their less disagreeable odor. Several oils of pine are used for the purpose, according to convenience in procuring them, but that prepared from the Seoteli fir tree (*oleum pini sylvestris*) seems to be in greatest favor. They answer the indication in most instances, but their effect is less active than that of turpentine.

Lewin‡ speaks of the use of the oil of mountain pine (*pumélion*), with a few drops of which he saturates a small piece of cotton, which is then placed in the bowl of a small smoking-pipe, through which the patient inspires for several hours at a time. This oil, he states,

* Bellini (*Lo sperimentalista et l'imparziale medico*), *La Tribune médicale*, 1868, p. 551.

† Berlin. klin. Woch., 1871, No 25.

‡ Op. cit., p. 207.

contains less resin than oil of turpentine, and is not unpleasant to the taste. The breath and urine soon acquire its peculiar odor, proving its absorption. It seems partly to induce contractility of the sluggish and relaxed vessels, and partly to act as an excitant and expectorant to the mucous membranes. More than from three to five drops are not to be given in a single day, because a larger quantity may become too stimulating. Dr. Lewin has employed such inhalations with success in chronic pulmonary catarrhs, and in pulmonic blennorrhœa; and Dr. Boer recommends its loosening effect from the relief experienced by himself in a tight catarrh. It was at a much earlier date employed by Copland in bronchitis, and recommended by him.

More recently* Prof. Gerhardt, of Jena, has made some further investigations into the action of the Scotch oil of pine (*sylvestris*) in chronic affections of the respiratory organs. Into a basinful of hot water he drops from six drops to two teaspoonfuls of the oil, and the patient breathes, through a tube, the vapor that is given off, from half an hour to two hours daily. The effect of this inhalation was found to be very similar to that produced by the oil of turpentine, only that the latter was rather more antiseptic, and the former more astringent and sorbefacient. The best results were obtained in chronic catarrh of the larynx or bronchi, and also in dilatation of the minuter bronchi. One case of the latter was so far relieved after four weeks' inhalation, that the lessening of the calibre of the bronchi was noticeable, and the expectoration, which previously had been profuse, decreased in quantity, and eventually ceased; while

* Lewin, op. cit., p. 208.

an inhalation of sal ammoniac instituted earlier had been followed by hardly any result. In phthisis the benefit was but slight. The inhalations of the oil of pine were not always well borne, but in the majority of cases soon effected a diminution in the amount of expectoration.

The inhalation of this oil of pine (*sylvestris*) is highly recommended by Dr. Morell Mackenzie, of London, as a mild but useful stimulant in chronic laryngitis. His formula is two drachms of the oil of pine, with sixty grains of light carbonate of magnesium in three ounces of water; a teaspoonful of which is to be thrown upon a pint of water at 150° F. for each inhalation. I have had considerable satisfactory experience with this formula in simple chronic bronchitis, and in the torpid chronic bronchitis of phthisis, as well as in chronic laryngitis. I have also used the other oils of pine with similar good results.

Dr. Leopold Dittel* speaks well of the inhalation of the ethereal oil of pine in catarrh of the pelvis, of the kidneys, etc.

OTHER ESSENTIAL OILS.

Various essential oils have been employed, chiefly as a matter of convenience, to take the place of infusions of seeds and leaves of the plants in which they are contained. They are usually mixed with water with the addition of carbonate of magnesium. Of these we may make mention of the oils of aniseed, caraway, cassia, cinnamon, cloves, cubeb, hops, juniper, marjoram,

* Schmidt's Jahrb., 1874, May 12th; Brit. and For. Med.-Chir. Rev., October, 1874, p. 510.

mint, and sage. Their general effect is mildly stimulant, and they are applicable to walking and working cases of chronic affections of the mucous membrane of the respiratory tract generally. The formula given in connection with the oil of pine will serve as a type for the entire series.

OXYGENATED ESSENCES.

Dr. Jules Cheron* claims that inhalations of the vapors of oxygenated essences, such as camphor, chamomile, cedar, eucalyptus, etc., will arrest the destruction of the lung-tissue in chronic phthisis.

CREASOTE.

Creasote may be inhaled in the proportion of three to fifteen drops to the ounce of water, heat being applied; or it may be employed undiluted at ordinary temperatures. It may be inhaled from any of the inhalers; or very simply, by pouring boiling water over a few drops of creasote in the bottom of a teapot, and inhaling through the spout. A formula recommended by Mackenzie† is of the same character as those generally used by him, viz.: Beechwood creasote, half a fluid ounce; light carbonate of magnesium, ninety grains; water to three fluid ounces; a teaspoonful in a pint of water at 150° F. for each inhalation.

Creasote inhalations will, it is said, often relieve the irritative cough of phthisis; allaying the irritation, checking the secretion, and facilitating expectoration. Thus, even though they may have no specific remedial agency, they act beneficially by conserving the patient's

* Gaz. hebdom., December 30th, 1872.

† Op. cit., p. 84.

strength, and preventing exhaustion from paroxysms of severe cough and dyspnoea.

Inhalations of vapors of creasote are reported to agree usually very well from the first; but in irritable constitutions, where they are not so readily tolerated, it has been recommended to subdue the hypersensitivity of the mucous membrane, by a previously instituted inhalation of the vapor from conium; and where there is any tendency to spasm, to add a few drops of the liquor potassæ at the moment of employing the inhalation.

Dr. Elliotson* records that in phthisis, he has, in many instances, caused patients to breathe for four or five minutes at a time, and four or five times a day, a mixture of creasote with mucilage and water; but without any decided result. He has found such inhalations useful, however, in cases of bronchitis with profuse discharge, those designated as bronchorrhœa; he has also found them useful in asthma; and so likewise in chronic affections of the larynx, trachea, and bronchi generally, he has found them of great advantage, both when used alone, and when conjoined with other medications; furthermore, he has not known any inconvenience to have resulted from their employment in a single instance.

MM. Serres and Andral, in their report read at the séance of the Parisian Academy of Sciences, Nov. 30th, 1857,† upon fumigations of acetic acid and creasote in the treatment of chronic bronchitis, recommended by Prof. L. Mandl, state that the varieties of bronchitis for which this treatment is recommended are: the dry

* Med.-Chir. Trans., vol. xix, p. 217.

† Gaz. hebd., December 11th, 1857.

catarrh of Laennec; chronic bronchitis with unilateral suberepitant râle; and the bronchitis of pleurisy. These three varieties form a group which is designated by Mandl under the name of (*bronchite sèche*) dry bronchitis, and characterized by the paucity of symptoms furnished by auscultation and percussion. The treatment consisted simply in the employment of warm fumigations by means of the apparatus described and figured at p. 26. Into the vessel are introduced sixty grammes of water, and five grammes of a solution composed of five grammes of creasote, fifty grammes of acetic acid, and five hundred grammes of water. The liquid is then heated, and the fumes that arise are inspired by the patient. The strength of the mixture is to be gradually increased, according to the duration of the malady, the susceptibility of the larynx and bronchi, and so on. Chronic mucous catarrh will not yield to the acid fumigations as readily as the dry bronchitis. In such cases he employs the emetics in addition, repeated whenever indicated by the abundance of râles. In the pituitous catarrh, properly so called, so frequently connected with an affection of the heart, and which in all cases, especially when it has existed several years, denotes a considerable degree of alteration of the mucous membrane of the bronchi, the acidulated fumigations, if well supported, will ameliorate the condition of these tubes, but will not restore their normal characters.

I have sometimes found creasote inhalations of much apparent use in the treatment of chronic coryza or so-called post-nasal catarrh, inspired through the nostrils after thorough cleansing by douche and syringe.

Naphtha (wood naphtha), introduced into practice by

Crichton in 1816, at one time* attracted some favorable attention as a remedial agent in phthisis, diminishing dyspnœa, relieving cough, and facilitating expectoration; its action being quite analogous to that of creasote.

Benzine, the product of the distillation of coal naphtha, has been employed by Loehner† in the treatment of whooping-cough; small quantities being placed in a number of shallow vessels and arranged at convenient points about the bed of the patient.

Prof. Chapman‡ found benefit from the fumes of concentrated pyroligneous acid in foul ulcerations of the throat and nostrils.

Of late years the use of creasote and allied products has been almost entirely superseded by the substitution of carbolic acid.

CARBOLIC ACID.

Vapors of carbolic acid are employed in the same affections for which creasote has been recommended, and have, in great measure, superseded the use of the latter remedy. From one to ten drops or more of the concentrated acid, or an equal number of grains of the crystallized acid, with an equal quantity of alcohol, in a draehm of water, may be thrown upon a pint or more of warm water. A bit of cotton, upon which a few drops of the concentrated acid has been poured, may be placed in a wide-mouthed vessel, and the vapor be inhaled at ordinary temperatures. Dr. Somerville Oliver suggests wearing a small net or respirator, in which a

* Hastings, Pulmonary Consumption treated with Naphtha, London, 1845.

† Gaz. médicale, October 20th, 1866.

‡ Therapeutics, vol. ii, p. 36.

woollen cloth, impregnated with the solution, is to be introduced.* It may be exposed by the bedside in saucers, or other shallow dishes, to impregnate the atmosphere. I have frequently used it in combination with tincture of iodine in chronic laryngitis and bronchitis, and with very satisfactory effects. It is also useful in all cases of fetid odor from the mouth and air-passages.

Dr. Mackenzie recommends it in syphilitic and carcinomatous affections of the larynx, etc.

In combination with ammonia, it has been recommended by Dr. Hagner to avert a cold or catarrh. A mixture containing five parts of carbolic acid, fifteen of rectified spirits of wine, five of strong water of ammonia, and ten of water, is kept for use in a glass-stoppered dark bottle. When a catarrh is commencing, the patient is to pour a few drops on three or four layers of blotting-paper, which he is to take in his hand, when, closing his eyes, he is to take deep inspirations as long as any vapor is given off; and this process is to be repeated at intervals of two hours.†

Dr. Burchardt, of Berlin, has reported favorable results in whooping-cough from the vapors of a solution containing from one and a half to two per cent. of carbolic acid, boiled in the boiler of a Siegle or similar apparatus, inhaled three times a day into the widely opened mouth, at a distance of about twenty centimetres from the extremity of the tube. The violent paroxysms of cough disappeared in two or three days, and the whooping-cough was succeeded by a simple catarrh in the space of about eight days. This kind of medication

* *The Lancet*, July 8th, 1871, p. 45.

† *E. Brand, Berlin. Klin. Woch.*, 1872, No. 12.

often succeeds in a remarkable manner in catarrhal affections of the vocal cords, and proves equally useful in chronic catarrh of the trachea, especially when the expectoration takes on a putrid character, and presents the yellow tint peculiar to the production of fungi.*

Carbolie-acid vapor has been also recommended in whooping-cough by Dr. Robert J. Lee.†

OPIUM AND OTHER NARCOTICS.

OPIUM.—Opium, as is well known, has long been inhaled in the East for sensuous purposes. The Chinese place a portion of the extract, the size of a pea, into the bowl of a pipe, which is heated over a flame for a time, and then the opium is set on fire and the smoke forcibly inhaled. Its effects are sedative and narcotic.

Ethmüller‡ first employed opium fumes in Germany for therapeutic purposes. He let from ten to twenty grains of opium burn on glowing iron by the patient's bedside, and found the practice useful in hysteria, melancholia, excitable nervous fevers, and severe spasms.

The fumes of opium have been recommended in coryza.§

Dr. Snow's method is to place the required quantity of the extract, in the form of a pill, upon the capsule of his inhaler (described on pages 27 and 28), and then the spirit-lamp is lighted beneath; the patient beginning to inhale immediately, and continuing to do so until volatilization ceases, the process usually lasting

* London Medical Record, Feb. 3d, 1875, p. 73.

† Brit. Med. Jour., 1875, p. 229.

‡ (Med.-Chir. Zeitg., 1809, 3, p. 255); Waldenburg, op. cit., p. 595.

§ Am. Jour. Med. Sci., July, 1855, p. 207.

about ten minutes, and leaving as residue a porous carbonized mass.

Morphia, in doses of half a grain, may be used for inhalation in preference to opium, than which it is said to be pleasanter, inasmuch as the extract of opium supplies some smoke in addition to its active principles. The morphia is mixed with dry plaster of Paris to increase its bulk.

Inhalation of the fumes of opium is recommended by Armand,* not only in affections of the respiratory organs, but also in nervous affections of the heart, in the various neuralgias, and in muscular and articular rheumatism. He has found it a very suitable remedy in bronchitis, chronic laryngitis, whooping-cough, and asthma. He allows the patient to smoke from five to fifty centigrammes of the extract within the twenty-four hours, an amount which he states can be smoked without any unpleasantness and with a very favorable action.

The vapor from the camphorated tincture of opium, an ounce or more thrown upon a pint of steaming water, will often be found to act well as a sedative in cases of moderate irritability of the larynx, with continuous disposition to cough ; the combined effects of the camphor, benzoin, and aromatics with the opiate rendering it usually particularly grateful to the parts. It can also be added with advantage to other substances to modify their pungency.

The extract of lactucarium has occasionally been employed as a substitute for opium.

CANNABIS INDICA.—This remedy is used by the Per-

* Gaz. méd., Paris, 1868, 50; Le France méd., 1868, 99, p. 739.

sians, by inhalation, in diseases of the respiratory organs.*

It has been recommended in phthisis by Desmartis.†

STRAMONIUM.—Inhalation of the fumes of the datura leaves has long been a popular remedy for asthma in the East Indies.

The use of the datura stramonium in asthma was brought into notice by Dr. Sims, in 1802,‡ the common thorn-apple being substituted by one of his patients for the wild thorn-apple (*datura ferox*), imported from the East Indies, the supply of which had given out in this instance. The latter plant seems to have been used for the purpose in the East Indies for a very long time.

Inhalation of vapors of stramonium has been highly extolled by Martin Solon, Andral, Troussseau, Théry, and many other Continental authorities, and by Salter, of Great Britain. It has been employed a good deal in the United States, though not much positive information has been recorded. These vapors are also said to give relief in the exhausting cough and impeded respiration of phthisis, in spasmodic and hysterical cough, and in dyspnœa from any cause.

The dried leaves, the fibres of the root, or the seeds, may be smoked alone, or with tobacco if the patient is accustomed to tobacco, either in a pipe or a cigarette; or cigars may be steeped in a strong decoction of stramonium and then dried until fit for smoking.

As ordinarily smoked, it is doubtful whether the remedy gains access into the lungs; but if the smoke, as

* Polak, Bericht der deutschen Naturforscher. Versammlung zu Königsberg, 1800; Waldenburg, op. cit., p. 604.

† (Union méd., 1861, Nov. 7). Waldenburg, op. cit., p. 601.

‡ Review in Edinb. Med. Jour., July, 1812, p. 365.

it issues from the mouth after the puff of the smoker, is drawn back by an act of inspiration, it will then be inhaled into the lungs, and the effect will be more certain and more prompt; otherwise it does not enter the larynx, and the effect is in great measure due to absorption by the mucous membrane of the mouth and pharynx.

Extract of stramonium has been used by inhalation in the same manner as extract of opium, in cases of asthma, and with asserted relief.

Dr. Nevins* directs an ounce of the dried leaves, moistened in a solution of half a drachm of the watery extract of opium, dried, and rolled in paper into cigarettes, in attacks of nervous (spasmodic) asthma, in hysterical coughs, and in dry, obstinate coughs symptomatic of more or less severe chronic affection of the lungs.

M. Dannecy, of Bordeaux, finding that asthmatic patients had experienced considerable relief from smoking the leaves of borage and pellitory,—plants containing much nitrate of lime, endeavored to avoid the too copious production of smoke in the narcotic plants most usually employed, which often fatigues patients and sometimes excites cough, by saturating the leaves of belladonna and stramonium with nitre. The plants, dried and conveniently spread out, are watered with a solution of nitrate of potassium, in the proportion of three ounces of the salt to rather more than two pounds *avoirdupois* of these plants. As the solution penetrates the entire vegetable tissue, the plants, when dry, will burn

* Art of Prescribing, p. 298.

completely without the formation of the objectionable pyrogenous products.*

Dr. Salter† thinks the inhalation of the fumes of stramonium does more in the way of prevention than cure ; that he has seen better results from the long-continued practice of smoking a pipe of it the last thing at night, whether an attack of asthma is threatening or not, than by waiting until a paroxysm comes on.

Three or four pipefuls of stramonium are usually smoked at each administration ; or the smoking is continued, with interruptions, from a few minutes to half an hour.

In irritable bronchitis, stramonium is sometimes smoked in the same way, as a sedative, with equal parts of sage;‡ or it may be made into cigarettes, twenty of which are formed of an ounce of stramonium and half an ounce of sage.

Stramonium cigars are usually made from datura *tatula*, which is stronger than the datura stramonium.

BELLADONNA.—Belladonna, employed in a similar manner, has been recommended by many of the same authorities for the cure of spasmodic asthma. It is sometimes mixed with tobacco and smoked ; and sometimes the vapor from an infusion in water is inhaled. The latter plan has been recommended in whooping-cough.

The fumes of belladonna have been recommended by M. Schroeder as an effectual agent in arresting haemoptysis, in effecting which, it at the same time allays cough

* (Bull. de thérapeutique, 1857, t. 111, p. 455; Dublin Hosp. Gaz., March 1, 1858); Am. Jour. Med. Sci., July, 1858, p. 204.

† On Asthma, Phila., 1864, p. 112.

‡ Troussseau, Art of Prescribing, London, 1858, p. 298

and producées a feeling of relief in the chest. The plan pursued by him was to cut the dried leaves into small pieces, and throw about two drachms upon burning coals, so that the patient may be enabled to inspire the fumes as they arise. It is said that inhalation of the steam from a decoction of these leaves, or their internal administration, does not appear to have an equally beneficial effect.*

Belladonna and stramonium are often used in combination, to overcome the paroxysms of asthma; and most of the cigarettes vended for use in that malady contain the two ingredients.

Trousseau's formula for narcotic cigarettes is as follows: Fol. belladonnæ, 30 centigrammes; fol. hyoscyamus, 15 centigrammes; fol. stramonii, 15 centigrammes; ext. opii. gummos, 13 milligrammes: aquæ laurocerasi, 9½ grammes.

The famous cigarettes of Espie are made according to the same formula, with the addition of 5 centigrammes of phellandrium aquaticum.

CONIUM.—Conium was used by Scudamore to lessen the irritation of the iodine vapors (see p. 98) so much extolled by him. Snow† employed a cold inhalation of one part of conium to nine of alcohol, to relieve cough and facilitate respiration. Stokes‡ found conium useful in bronchitis and in phthisis, twelve or fifteen grains of the extract being diffused in a proper inhaling apparatus, and the vapor drawn into the lungs for a quarter of an hour, once or twice a day.

* (Annali universi di médecine, April, 1845); Ranking's Abstract, 1845, 11, p. 75.

† London Med. Jour., February, 1851.

‡ Diseases of the Chest, Philadelphia, 1837, p. 83.

HYOSCYAMUS.—Dr. Pearson, of London, was in the habit of using in phthisis, the inhalation of the narcotic vapors evolved by the maceration of from a scruple to a drachm of the leaves of hyoscyamus in an ounce of ether.

TOBACCO.—In individuals who by habit have not lost their susceptibility to the effect of this plant, the inhalation of the smoke from tobacco will sometimes serve a good purpose in nervous affections of the respiratory organs. It has thus been recommended in ordinary spasmodic cough, in whooping-cough, in asthma, in phthisis, and in spasmodic croup.

Prof. Chapman, of Philadelphia, prescribed the smoking of tobacco with success in the spasmodic croup of a female adult.* He employed it for the purpose of exciting nausea and producing relaxation of the spasm of the larynx; and he also reported advantage from its use in the dyspnoëtic condition of asthma.

In hay-asthma, according to Salter,† tobacco pushed ad nauseam gives more relief than any other remedy, and is sometimes the only effectual one. He preferred what is known as the bird's-eye brand.

To produce its due effect, care should be taken that the tobacco smoke be inhaled into the lungs.

SOME narcotic substances are volatilized by the direct action of heat, the inhalations being dry; and others in association with vapor of water in infusion, the inhalation being moist. Only such substances as contain volatile ingredients are suitable for administration by the latter method, but few alkaloids being volatile at tem-

* Am. Jour. Med. Sci., vol. i, 1827-28, p. 477.

† Lancet, 1858, September 11th, p. 302; On Asthma, Phila. ed., 1864, p. 122.

peratures employed for therapeutic purposes. Nicotine and coniin are volatile; consequently tobacco and conium can be used; belladonna and hyoscyamus can be used; but digitalis and opium are not suitable for this method of administration.

HYDROCYANIC ACID.—Hydrocyanic acid in weak solution is sometimes employed by inhalation, a few drops (five to ten) of the dilute acid being thrown upon a quantity of hot water.

Maddoek* and some others have reported favorable results in whooping-cough and asthma. Snow and others, on the other hand, have not witnessed any special beneficial results from hydrocyanic acid or its preparations. It is sometimes useful in allaying the distressing cough of the chronic laryngitis of phthisis. It is sometimes used in the form of cherry-laurel water, alone, or as the menstruum for astringent and other inhalations in which the addition of a sedative is desirable.

NITRATE OF POTASSIUM.

Inhalation of the fumes arising from the ignition of saltpetre, a remedy first employed in this country, has been found of much service in the paroxysms of asthma. Pieces of bibulous paper, such as ordinary red blotting-paper, are soaked in a saturated solution of the nitrate and then dried. When to be used, the paper is set on fire in a convenient vessel and the patient inhales the fumes as they are given off, or merely breathes the air of the apartment. Sometimes the impregnated paper is smoked in a pipe in the same way as ordinary tobacco. These fumes have likewise been used with some

* Op. cit., p. 73.

succes in whooping-cough, and in spasmodic coughs generally. They are recommended by Mackenzie* in spasmodic dyspnoea due to spasm of the adductor muscles of the vocal cords. More asthmatic patients, I believe, are benefited by this smoke than by any other single remedy. Leaves of belladonna and stramonium are sometimes steeped in a saturated solution of this salt, so as to seenre the combined effects of the narcotic also. A good deal depends upon the manner in which nitre-paper is prepared. Dr. Salter† calls attention to the fact that the paper, if too thin, will not take up sufficient nitre, and if too thick will make the fumes too carbonaceous; and that the strength of the solution should be saturated at the ordinary temperature lest the paper become too much impregnated with nitre, and thus burn too fast with a sudden explosive flame. The paper should have little or no wool in its composition. He states that there should be no brown smoke in its combustion, but light, clear, white fumes. He gives the following method of preparation, recommended by a patient, which he found very efficacious: "Dissolve four ounces of saltpetre in half a pint of boiling water; pour the liquor into a small waiter just wide enough to take the paper; then draw it through the liquor and dry it by the fire." The paper may be ent in pieces about four inches square, one or two of which may be burned at once.

CAMPHOR.

This substance was probably first employed by inhalation by the Arabian physician, Avicenna. In the form

* Op. cit., p. 73.

† On Asthma, Philadelphia ed., 1864, p. 151.

of vapor, eamphor is sometimes inhaled in coryza, asthma, croup, spasmodic coughs, and chronic catarrhal affections; and there is no doubt that its constitutional impression may be obtained in the same way. It may be inhaled by means of an ordinary inhaler, placed in water more or less heated, to favor the volatilization of the eamphor.

A drachm or more of the tincture of camphor may be placed in an ounce of water, and inhaled with the watery vapor evolved by a spirit-lamp, care being taken to protect the eyes from its irritating influence.

In the inhalation of camphor, care must be taken to arrest the process when signs are exhibited of its acting on the brain.

M. Raspail recommends that a small tube, a quill, for example, should be filled with the coarsely powdered drug, and loosely closed at each end with a cotton wad, so as still to admit the passage of air; and that this should be used in the same manner as a cigar, but without burning.

Dr. Snow, of London, has reported relief to the cough of phthisis by the inhalation of vapors of eamphor.*

A piece of eamphor held before the nostrils, so that its vapor may be snuffed up into the nasal passages, is sometimes beneficial in coryza, and in serous catarrh of the nasal passages. Powdered eamphor has been recommended to be used in the same way, and for the same purpose, as well as for the relief of various spasmodic or catarrhal affections of the air-passages.†

* London Med. Jour., February, 1851.

† Wood's Therapeutics and Pharmacology, Philadelphia, 1860, vol. i, p. 714.

Inhalations of the vapor of camphor were much employed by Dr. Bödtcher, of Copenhagen, especially in spasmody affections.

The inhalation of vapors of camphor with those of iodine have been used successfully by Prof. A. P. Merriil, of Memphis, Tenn., more recently of New York.*

Vogel has had successful results in spasm of the glottis, from the constant use of a camphorated atmosphere, secured by placing a bit of camphor in a bag of gauze or linen, to be worn about the patient's neck.†

Waldenburg‡ has tried this method in similar cases with considerable benefit, and also in a case of spasmodic cough.

The ordinary spirits of camphor, cautiously inhaled from the bottle, will usually give all the advantages of the drug itself. Such inhalations I have sometimes found efficient in facilitating excretion, and in toning the mucous membrane in chronic nasal catarrhs. The inhalation of camphor is occasionally employed as an antiseptic during direct exposure to typhus and typhoid fever and the like.

LIME.

The direct inhalation of lime in sthenic and in diphtheritic croup—or rather vapor of water containing small particles of lime in suspension—was suggested by Dr. A. Geiger, of Dayton, Ohio. The vapor is produced by pouring hot water upon small pieces of unslaaked lime. The ebullition is such in the process that a profusion of minute particles of the lime becomes detached and forced

* Memphis Medical Recorder, March, 1855, p. 228.

† Lerbuch der Kinderkrankheiten, Erlangen, 1860, p. 253.

‡ Op. cit., p. 654.

up with the steam arising from the vessel in which the slackening is going on, and remain with it in suspension, so that the compound can be readily inspired.

Dr. Geiger, after narrating a very interesting case of diphtheritic croup in which large portions of membrane retaining the cast of the entire trachea were coughed up, and a portion of which he found to become dissolved in lime-water,* continues :

" I determined to try the effects of the lime in the next case of diphtheria, or pseudo-membranous croup, occurring in my practice. The first case that presented itself was one of croup, in a boy about four years of age (son of Irish parents), residing some two miles from the city. The boy had already been sick two days before my visit. When called, I ordered the father to take out with him some unslackened lime, which he did. Upon my arrival at the house, I found the patient sitting up in bed : severe and distressing dyspnoea ; the face and body covered with perspiration from his efforts to get his breath. The usual harsh, dry cough, and the symptoms all indicating the last stages of pseudo-membranous croup, I determined to try alone the effects of the lime, as I saw no hope in any other treatment. But in what way could I bring it in contact with the membranous formation to dissolve it ? I hit upon the following expedient : I placed some unslackened lime in a saucer, and then, after throwing a cloth over his head, held the saucer under, so that he was compelled to breathe the fumes arising from the lime in the process of slackening. I retained it for a few minutes and then removed it. The breathing was some easier, and directly he expectorated a large quantity of tough mucus and phlegm, and was very much relieved. In this process, the steam arising from the lime in slackening, contains in it particles of lime which are thus, by inhalation, brought in contact with the membrane in the windpipe. I ordered lime-water and milk to be given internally, and the inhalations to be repeated in the same way, whenever the symptoms of suffocation were severe, and that the father should report to me in the morning the boy's condition.

" He came in the following morning, said ' he was much better ;

* Med. and Surg. Reporter, Philadelphia, March 24th, 1866.

that the night before, after again inhaling the fumes of the lime, he had vomited up a lot of tough stuff, and got better right away.' I prescribed a cathartic to be given him, and the fumes of the lime, if he choked up again. I saw the patient no more. The father reported from day to day that he was getting better, and finally, that he could 'eat as much as ever.' "

Dr. Geiger, in the same communication, reports another case of a fleshy little boy, three or four years of age, attacked two days previous to his visit. There was hard breathing, stridulous cough, with evidence of the formation of membrane, though to less extent than in the case above. A purge was ordered, and directions given how to employ the lime inhalations. Visiting the child again in a few hours, he found the difficulty in breathing quite relieved; the mother reporting that the lime had acted like a "miracle;" that after breathing the fumes for a few minutes, he vomited freely and was at once relieved. On the day following, the child was so well that further medication was unnecessary.

Dr. Geiger also states that Dr. O Crook, of the same city, reported six cases of diphtheria and membranous croup, in which the fumes of lime and lime-water were used, five of which cases recovered.

Dr. Geiger reports another successful case in the same journal for March 10th, 1866.

Dr. Alexander J. C. Skene, of Brooklyn, N. Y., reports* that he has tried the inhalation of lime-water broken up into spray by Richardson's Spray Producer, in several cases of croup, and believes that he has observed marked advantage derived thereby.

Dr. Thomas Byrnes, of Walcott, Iowa,† reports a case of diphtheria in a child seven years of age, in which, when he was called to the case, the tonsils were large, and the mucous membrane of a bright-red color, a small patch of membrane covering the left tonsil. The constitutional symptoms were very slight. He swabbed the throat with tr. ferri chloridi, and administered five drops internally every hour. The following morning the tonsils were covered with false membrane, which had ascended to the palatine arches. Small patches were visible on the uvula also. The cervical and submaxillary glands had become very much swollen, and painful to the touch. The lime was prepared for in-

* Med. and Surg. Rep., Dec. 22d, 1866, p. 527.

† Med. and Surg. Rep., Philada., July, 1866, p. 26.

halation, as directed by Dr. Geiger, and it soon exerted its beneficial effect. Small patches that covered the uvula were entirely dissolved, and those on the tonsils were diminished in size. The inhalations were continued at intervals of four hours. Towards evening, the false membrane had entirely disappeared, but returned again the next day, and was again removed by lime inhalations. The systemic affection in this case was combated by supporting measures, and the internal administration of iron.

Dr. C. V. Moore,* of Stillwater, New Jersey, writes as follows: "I have recently had two severe cases of diphtheria. In one the disease had invaded the larynx, causing loss of voice, croupy cough, and paroxysmal attacks of suffocation and dyspnea. Both cases were promptly relieved, and cured simply by the internal administration of small and oft-repeated doses of permanganate of potassa, and the inhalation of vapor of slackening lime. The relief from the inhalation was very marked, and the result was gratifying, both to the little sufferer, the friends, and most assuredly to the attending physician."

These cases were sporadic. Internal treatment, milk and beef tea.

Acting Assistant Surgeon Henry McElderry, United States Army,† reports a case of diphtheria, in which, in addition to supporting systemic treatment, the inhalation of lime with steam, from the action of hot water on unslackened lime, was employed with the successful removal of rapidly spreading diphtheritic deposit on the left tonsil and on the arches of the palate on that side. He writes that the instantaneous relief given by the inhalations, when he has seen so many remedies signally fail in diphtheria, has led him to attribute the very fortunate and successful issue in this case entirely to their influence. He has never seen any remedy act with more promptness or satisfaction than the lime inhalations did in this case.

Many more successful cases have been reported subsequently, confirming the statements and results of Dr. Geiger, with which my own experience is in full accord.

My own experience with inhalations of the hot vapor

* Med. and Surg. Reporter, Philada., Sept. 5th, 1866, p. 224.

† Med. and Surg. Reporter, Philada., April 28th, 1866.

from slackening lime has been decidedly satisfactory, and I would not like to be prohibited from employing it in the management of a serious case of membranous croup. In some dozens of cases, in private and in consultation practice, I have seen life apparently rescued through its agency. Of all the methods of treating croup advanced of late years, I know of no other that has held its ground so well as this. The general plan pursued by myself is to keep up a continuous evolution of steam from boiling water, and to administer the lime in the manner indicated by Dr. Geiger, for ten minutes at a time or thereabouts, whenever the respiration evinces the presence or formation of membrane; repeating it at intervals of half an hour, an hour, two hours, or longer, according to circumstances; and recurring to the remedy whenever the respiration is impeded by the exudation. I find a large piece of stiff wrapping-paper, the size of an ordinary newspaper, loosely folded into a funnel-shaped cone, one of the best means of directing the vapor towards the mouth of the patient. A large, stiff paper bag, with one of the corners cut off obliquely, and inverted over the vessel, answers the purpose admirably.

ARSENIC.

Vapors produced by burning sulphide of arsenic were anciently used in the East for medicinal purposes. Avicenna employed the fumes of arsenic in the treatment of asthma.* The poisonous effects of arsenical vapors in those unaccustomed to them are well known. Their therapeutical employment in chronic laryngitis and bronchitis, in asthma, in the treatment of chronic bron-

* Floyer, On Asthma, London, 1718, p. 169.

chial affections, and in phthisis, was revived by Troussseau,* in the form of the cigars of Dioscorides. This method consists in inhaling fumes arising from burning cigarettes, made from bibulous paper, saturated in a watery solution of arseniate of sodium or of potassium, from half a drachm to a drachm to the ounce of water. Each cigarette absorbs about half a drachm of the solution. The cigarette is to be smoked like an ordinary cigarette of tobacco; the patient inhaling the smoke into the bronchi from two to ten times during the process, and repeating it two or three times a day.

A correspondent in the *Medical and Surgical Reporter* has reported two cases of success in the treatment of spasmodic asthma,† the patients having smoked a small pipe, half full of tobacco, to which one-fourth of a grain of arsenious acid had been added. The cases were of more than twenty years' standing; and the attacks ceased after six days' use of the remedy, once daily.

In a case of painful neurosis of the larynx, Wistingenhausen‡ employed the vapor evolved by heating a couple of drachms of water, to which three drops of Fowler's solution had been added.

Dr. Anstie read a paper on cardiae neuralgia, before the British Medical Association,§ in which he stated that one of the two remedies which yielded him the best permanent results was arsenic given by the stomach or by inhalation.

* *Gaz. des hôp.*, 1841, No. 10. *The Prescriber's Complete Handbook*, London, 1858, p. 255.

† *Philada.*, November 16th, 1861, p. 164

‡ (*Petersburger med. Zeitschr.*, 1862, p. 129), *Waldenburg, op. cit.*, p. 674.

§ *Practitioner*, October, 1868, p. 257.

MERCURY.

The inhalation of mercurial vapors has been employed for ages in India and in Arabia for the purpose of exciting salivation in the treatment of certain diseases. The patient is covered with a blanket, beneath which is burned a candle, composed of cotton cloth smeared with melted beeswax, and impregnated with an equal quantity of cinnabar in powder; the vapor therefrom being inhaled into the respiratory tract.

The inhalations of vapor from cinnabar were employed at a very early date, in the treatment of constitutional syphilis; and the names of de Vigo, Guido, Fracastori, and others,* are associated with their use.

Dr. Samuel Jackson, of Northumberland, employed the vapors from calomel, and devised a very convenient apparatus for their administration,† which consists of a tin vessel the shape of an inverted funnel, to the pipe of which flexible tubing is attached. A little door permits the introduction of a heated iron (about two pounds in weight), which rests on a sheet-iron stand. The iron is heated not quite to redness, and placed upon the stand. Ten grains of the powder (separated by filtration from a mixture made by shaking four ounces of calomel in six ounces of water, to which two drachms of ammonia water, or the simple or aromatic spirit of ammonia, has been added) is thrown on the iron, and the door is then closed. The vapor is evolved in the reservoir and inhaled through the flexible tube. When evaporation ceases, another portion of powder is thrown on the iron, and in this way from two to six portions are used in

* Fracastori, in Copland on Bronchitis, 1866, p. 133.

† Am. Jour. Med. Sci., vol. i, p. 321.

succession ; the entire process being repeated every two, four, six, or eight hours, according to the exigencies of the case. Salivation usually ensues at a period varying from twelve to seventy-two hours.

Dr. Nevins relates his experience with mercurial vapors in the treatment of aphonia, fetid coryza implicating the frontal sinuses, nasal polypus, obstruction of the Eustachian tube, and asthma.* He employed the cigarettes recommended by Rousseau,† and made as follows : "Take of nitrate of mercury and strong nitric acid, of each fifteen grains, and distilled water six drachms, or a sufficient quantity. Mix the acid and water, and dissolve the nitrate of mercury by the aid of a gentle heat, which may be obtained on the top of an ordinary oven. Then soak in the solution a piece of thick, white blotting-paper, six inches by eight, and dry it. Before it is quite dry, cut it into eight slips, and roll each of these round a thin pencil, so as to make a small paper tube. To prevent this from unrolling, the free edge should be gummed. The cigarette is now complete, and when dry, will burn like touch-paper when smoked. The interior may be stuffed with tobacco if desired, or the paper itself may be rolled into a cigar, along with tobacco in the first instance ; but it ought always to be rolled before being quite dry, as it is liable to become brittle when perfectly dry, and to crack in the operation of folding. It sometimes happens that the nitrate of mercury does not become perfectly dissolved, even by the aid of the gentle heat, in which case

* (Liverpool Med.-Chir. Journal, Jan. 1859) ; Am. Jour. Med. Sci., April, 1859, p. 541.

† The Prescriber's Complete Handbook, London, 1858, p. 247.

the mixture should be stirred up previous to the paper being immersed in it, and a slight degree of agitation of the liquid will diffuse the undissolved nitrate uniformly over the paper."

M. Thierry advises that these cigarettes should be prepared with a solution of corrosive sublimate.

It is intended that eight or ten mouthfuls of the smoke should be inhaled into the bronchi several times a day.

Trousseau recommended the use of these cigarettes in simple chronic laryngitis, as well as in pharyngitis and laryngitis of syphilitic origin.

Dr. Polak* speaks of the mercurial inhalations employed in the Orient for the treatment of syphilis. He says that in Persia the readiest method of curing syphilitic affections is by means of inhalation. There is added to the moistened narghilè-tombac a trochiseus of cinnabar; and a pipe thus prepared is smoked by the patient once or twice a day.

The ordinary formula for the pastille is as follows : Cinnabar, two muskals (1 muskal is equal to 66 grains apothecaries' weight); catechu, two muskals; borax, one-half muskal; Lawsonia, two muskals; china nodosa, three muskals ; combined with mucilage of gum arabic, and formed into twelve troches. Another formula is cinnabar two M., mercury two M., leaves of cannabis indica three M., made with mucilage into fourteen troches.

One or two of these pastilles is to be smoked daily, and in the following manner : The smoke is inhaled into the lungs, retained there for a few moments, and then expired through the mouth alone or through the

* Wiener medic. Wochenschrift, 1860, No. 36.

mouth and nose together. Generally, a moderate mercurial stomatitis ensues after the eighth or tenth inhalation; and this is a sign for discontinuing the process. During the treatment the patient must rinse out the mouth frequently, and be careful to observe great cleanliness. The diet consists of milk with sugar, rice and milk with sugar, and also sheep's-foot jelly. Salt food, acids, and fruits are interdicted. The mercurial stomatitis is treated with powdered sumac, with catechu, or the tabaschis (*bambus magnesia*), with gulnar (full flowers of the pomegranate). According to these investigations of Dr. Polak, no other method is comparable with that of these inhalations for the prompt treatment of syphilitic affections of the throat. Dr. Polak found that the inhalation of cinnabar was very well borne, even by young children; that six to eight strong pulls produced a slight sensation of approaching syncope, continuing, however, only for a short time, and allowing the operation to be repeated by the next day.

The treatment of croup and diphtheria by inhalations of the moist vapor of sulphuret of mercury (cinnabar) has been recommended by Abeille,* Bregeánt,† and others.

The vapors from preparations of mercury should be inhaled diffused in the vapor from hot water. The apparatus of Langlebert and Bumstead (pp. 28, 29) are especially adapted to generating mercurial vapors in combination with the vapor of water; the method usually adopted in consequence of the irritating qualities of the

* *Gaz. méd.*, Paris, 1867, pp. 527, 569, 582, 598; *Gaz. des. hôp.* 1868, 127; *Wien. med. Woch.*, 1869, 1, p. 10.

† *Gaz. méd.*, Paris, 1868, p. 80.

dry mercurial vapor, the bisulphuret (cinnabar) giving off sulphurous acid, and the protochloride (calomel) giving off hydrochloric acid fumes. Dr. Henry Lee* states that the irritating qualities of the vapor of calomel may be still further diminished by its being resublimed two or three times before it is used; by which action, as he conceives, any free hydrochloric acid is driven off. The apparatus employed by Mr. Lee is similar in appearance to that of Bumstead, only the case surrounding the spirit-lamp is made principally of wire-gauze, on the principle of the Davy safety lamp. The top of the case is fitted with a central, movable, small circular plate, surrounded by a trough, which should contain one ounce of water only. The water should be boiling when poured into the trough, or should be allowed to remain over the lighted lamp until it begins to boil, when the proper quantity (thirty grains, if it is intended to fumigate the entire body) of perfectly dry resublimed calomel is then spread out on the central small circular plate. This apparatus is intended chiefly for fumigations of the entire cutaneous surface from the neck downwards, the cloak in which the patient is enveloped being opened in front now and then during the fumigation, so that the vapor may be inhaled for a minute at a time, at intervals of five minutes, thrice at each sitting. It is recommended that the moistened calomel vapor pass for about six inches through the common air before it is inhaled.

CHLORIDE OF COPPER.

Dr. Th. Clemens, of Frankfort-on-the-Main, has communicated several articles to the *Deutsche Klinik*, 1865—

* The Lancet, Aug. 21st, 1875, p. 267.

66, on the use of the vapor from a chloride of copper by inhalation, and as a disinfectant. He asserts that it is an established fact, supported by experience, that workers in copper mines, and in copper fabrics, remain protected against the cholera poison. This led him to the employment of these vapors in the treatment of cholera, in connection with the internal and external use of the remedy. The vapor is produced by heating a solution of the chloride of copper, a drachm to the pound of alcohol, with the addition of two drachms of chloroform. He has used it successfully as a disinfectant in crowded hospitals, and it has proved effectual in epidemics of measles and scarlet fever. He has used the vapor by inhalation successfully in one case of pulmonary gangrene, and in two cases of pulmonary tuberculosis.

HOT WATER.

Last, and most important, we come to the vapor of hot water, so much employed to evolve the volatile ingredients of the various remedial agents discussed in the preceding pages.

It is well known that in many pulmonary complaints attended with more or less distress in breathing, advantage will ensue from continuous warming and moistening the air of the sick-chamber with a current of steam rising from a vessel of water kept boiling for that purpose. The warm and humid air inhaled, acts upon the irritated mucous membranes with a soothing influence similar to that excited upon external inflammations by warm fomentations, and thus contributes to the general comfort of the patient.

Direct inhalation of the vapor of hot water has long

been employed for local emollient purposes in the treatment of the various affections of the respiratory tract. It soothes inflamed tissue, cleanses the mucous surfaces, dislodges adhering secretions, relieves irritation, arrests cough, facilitates expectoration, and favors the resumption of impeded circulation.

Sir John Pringle* attested the good effects he had observed in pleurisy and pneumonia from causing his patients to breathe over the steam of hot water; a practice recommended by Boerhaave and van Swieten, and confirmed to him in repeated trials by Dr. Huck, who found it more beneficial when the phlegm was viscid, as well as more grateful to the patient, by adding a small portion of vinegar; and the distinguished editor of the re-publication adds, in a footnote, that too much cannot be said in favor of this simple and powerful remedy, for he has seen patients snatched from the jaws of death by it. He directs that where a prompt effect is wished for, water should be poured upon a heated shovel, the vapor in which case is poured in a stream into the lungs.

The vapor of hot water was strongly recommended in recent catarrhs by Dr. John Mudge.† This practitioner directed that the patient should keep his head under the bed-covers during the inhalation, the inhaler being placed beneath his arm-pit. In this way general diaphoresis was induced, in addition to the local effect upon the bronchial mucous membrane.

The vapors of medicated waters are often employed medicinally by inhalation. Boerhaave employed the

* Observations on the Diseases of the Army, with Notes by B. Rush, M.D., Philadelphia, 1812, p. 129.

† A Radical and Expeditious Cure for a Recent Catarrhous Cough, London, 1780.

vapor of water distilled over elder flowers, as a remedy in pulmonary catarrh.

Dr. Thomas found the frequent inhalation of warm steam from an inhaler his most efficient agent of relief in asthma.

Dr. Mackintosh recommended* the inhalation of hot vapor in croup, in bronchitis, and in scarlet fever.

Dr. Eberle recommended warm steam, with chamomile flowers and a little ether, in asthma; and warm water and vinegar in *eynanehe tonsillaris* and *trachealis*.

Dr. Tweedie† states that the inhalation of steam in some cases rendered slightly stimulant and alterative by the addition of camphor, turpentine, or the balsams, has been found useful in promoting secretion from the diseased membrane. He recommends, also, the use of sedatives, and antispasmodics, as belladonna, camphor, ether, and opium, by inhalation, in chronic laryngitis.

Winteringhausen, though disapproving of fumigations as advised by Bennet, Mead, and others, acknowledges the advantages derived from the inhalation of the steam of hot water, medicated vinegar of squills, etc.

Skoda‡ recommends the vapor of water in laryngitis and bronchitis; and John Hunter, both in the bronchitis of adults and of children.§

In like manner the vapor of water is often impregnated with the volatile oils of certain aromatic herbs steeped in the water, such as arnica, chamomile, chenopodium, sage, xanthoxylum, and the like.

* Practice of Physic.

† Diseases of the Respiratory Organs.

‡ Allg. Wien. med. Ztg., 1862, Nos. 16, 24, 26, 29; Waldenburg, op. cit., p. 571.

§ The Lancet, 1869, September 24th.

Impregnated with essences, such as cologne and the like, the vapor of water is often of much service in various affections of the respiratory tract.

In a personal letter (1867) from Dr. S. Waterman, Surgeon to the Metropolitan Police, New York, that gentleman has reported very highly of *aromatic alcoholic inhalations*. He says: "I have been in the habit for many years of making use of aromatic alcoholic inhalations, and I have no hesitation in saying that they are of the most signal service when properly employed. I have used for this purpose the best 'eau de cologne,' that of Maria Farina, which I mixed in teaspoonful quantities with boiling water on the stove in winter, and on a gas-stove in summer. It creates an atmosphere highly impregnated with the aroma of the volatile oil contained in the preparation, and is willingly inhaled by the patient. I have used these inhalations:

"1st. In the more advanced stages of croup, when, from the imperfect decarbonization of the blood, the nervous powers begin to fail, and paralysis of the nerves of the lungs is to be feared. In this state the inhalations act as a local stimulant, invigorating the nervous power, and often overcoming that dangerous state when no other remedy would do so. That these inhalations exert, also, a beneficial effect upon the nervous distributions of the entire mucous membrane of the fauces, larynx, trachea, and bronchi, in these cases, I now entertain no manner of doubt.

"2d. In bronchial disorders dependent upon a relaxed state of the mucous membrane, these inhalations have often proved highly useful. For adults they may be continued for days and weeks. They sometimes cause violent cough; but it is just in such

cases, where they exert a stimulating effect upon the mucous surfaces, that their effects will be found salutary."

The vapor of warm water has been found extremely serviceable in both sthenic and diphtheritic croup. Dr. Wanner* found it of great use. Dr. Jenner† recommends inhalations of water vapor with acetic acid in the early stages of the sore throat in diphtheria; a wine-glassful of vinegar to the pint of boiling water. Oertel‡ places his main reliance on vapor of hot water, in the local treatment of diphtheria, to promote suppuration and thus effect the removal of the exudation.

In addition to the authors named, many others have recorded similar opinions of the efficacy of the vapor of warm water in croup and diphtheria.

It is my own practice in severe cases of croup to keep up a continuous evolution of steam in the apartment occupied by the patient; providing, of course, for efficient ventilation by opening a window in an adjoining room or staircase; and I can cordially indorse the opinion as to the benefits claimed by others for this treatment.

There are various methods by which sufficient evolution can be maintained in the absence of special apparatus which direct the steam towards the patient. A large wash-boiler with clothes in it, which are raised out of the water every few minutes, is an appliance available in every house. Buckets of water, with hot bricks or hot bits of iron in them, may be renewed from time to time.

* Du croup et de son traitement par la vapeur d'eau, Paris, 1834.

† Diphtheria, Its Symptoms and Treatment, London, 1861, p. 66.

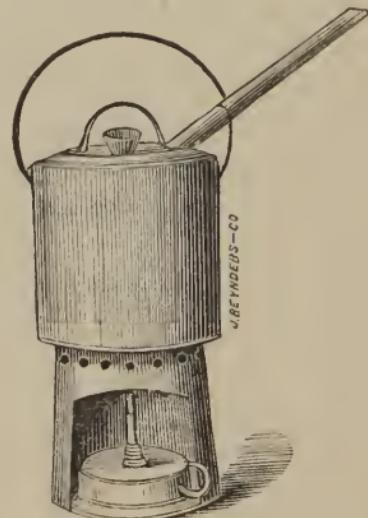
‡ Ziemssen's Cyclopedia of Practical Medicine, New York, 1875, vol. i.

The suggestion of Dr. Rush to pour water upon a hot shovel is not to be forgotten in an emergency.

The croup-kettle devised by Dr. Pretty, or some modification of it, is an admirable apparatus for the systematic evolution of steam.

Dr. Pretty's kettle, as described by Jenner,* is of tin, with a small aperture at top closed by a screw instead of an ordinary lid. A spout, three feet in length, projects horizontally from the upper part of the kettle; another spout projects obliquely upwards from near the bottom, ending in a spoon-like projection just under the slightly curved-down open mouth of the upper spout. The steam passes out of the upper spout, and the con-

FIG. 15.



Porter's Croup-Kettle.

densed vapor drops into the little spoon, and is returned by the lower spout to the bottom of the kettle.

The croup-kettle of Porter (Fig. 15) is a very efficient

* Op. cit., p. 67.

contrivance, and can be very easily extemporized by any tinsmith. It consists essentially of a tin vessel to hold the water, which is heated by a spirit-lamp. A funnel-shaped tube in the cover reaches to near the bottom of the vessel and serves to admit the external air, while a long oblique spout gives egress to the steam, and allows of its being directed towards the mouth of the patient.

Thus employed in croup, it is not unlikely that the supply of watery vapor prevents the congelation of pseudo-membrane to a certain extent, and keeps the exudation in a fluid state; thus facilitating its expectoration.

It is not improbable that all the benefit from the inhalation of warm vapor from slaking lime in croup acts in this way, affording moisture to the exuded matters, which in their congelation must part with some of their watery constituents; unless, perhaps, the particles of lime act mechanically in detaching membrane or prying it up so that the water can get beneath it.

After the performance of the operation of tracheotomy, it has been found serviceable to maintain a warm and moist atmosphere about the patient.

The value of inhalations of steam in cases of poisoning by corrosive vapors has been submitted to the profession by Samuel P. Duffield, Ph.D., who records a successful treatment of poisoning by bromine inhalation:

"The corrosive action of the bromine was such that the glottis had closed with a spasm, and did not yield willingly. The patient was brought near to a steam-pipe, the mouth held open, and the steam thrown from some distance, so as not to burn him, into his mouth and over his face. It had the desired effect, and the patient was subsequently sent home. The steam inhalations were continued for some time, and the patient recovered."

* Detroit Review of Medicine and Surgery; The Medical Record, New York, September 16th, 1867, p. 323.

PART II.

INHALATION OF NEBULIZED FLUIDS, OR SPRAYS.

NEBULIZED MEDICAMENTS
AND THE APPARATUS FOR THEIR PRODUCTION.

WHOEVER has seen a waterfall strike upon a rock is aware that portions of the stream become broken by the concussion into a coarser or finer spray, which remains, for a short time, suspended in the atmosphere. A stream of water forced through a narrow tube against a firm resistance will produce the same effect, as is sometimes scarcely seen in the more remote particles of the water as it is dashed from a building against which a fire-engine is playing. These remote particles, no longer in contact, are separated molecules, which, as soon as they alight, become condensed into drops.

On this principle, it occurred to Auphan, at Euzet-les-Bains, in 1849, to break up the mineral water of that watering-place into a fine spray, for purposes of inhalation, by forcing a delicate stream to impinge against the walls of the apartment. The same system was adopted shortly after at Lamotte-les-Bains; and subsequently Sales-Girons (in conjunction with M. de Flubé, proprietor of the baths at Pierrefonds, a watering-place near Compeigne, and who first suggested the idea of pulverizing liquids without employing a blast of air), constructed an apparatus for converting these mineral waters into the finest possible spray, with the idea of more thoroughly preparing them for the treat-

ment of diseases of the respiratory organs. Sales-Girons presented his first paper on the subject to the Parisian Academy of Medicine, May 20th, 1856; and a report upon it was made, in September following, by Messrs. Patissier and Henry. A few months later, on December 8th, 1856, he read a paper entitled "*Mémoire sur les inhalations pulmonaires, et sur la chambre de respiration nouvelle de Pierrefonds,*" before the Hydrological Society of Paris, in which he described his inhalatorium, and contended that the spray penetrated deeply into the respiratory tract, retaining all the elements of the mineral water. Doubts were expressed by many of the members as to the effect of such penetration; and shortly after, experiments were instituted at the different spas to solve the mooted question.

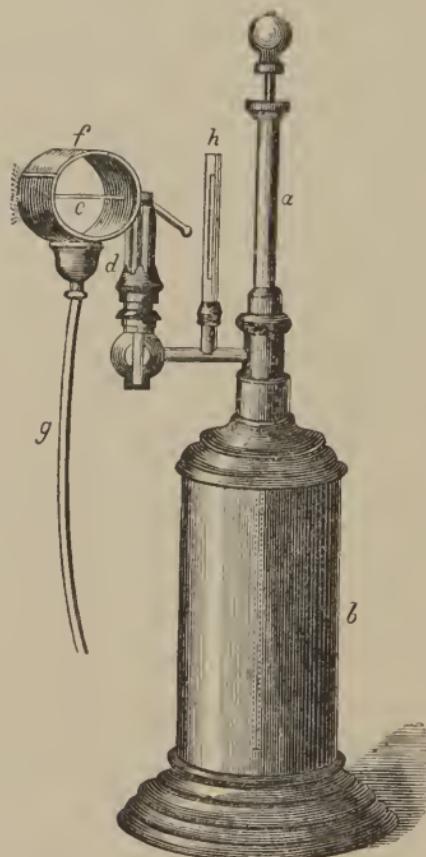
Sales-Girons's inhalatorium was a chamber seven metres long, four and a half metres wide, and three metres high, in which it was intended that several patients, from one to fifteen, should take inhalations at the same time. During the inhalations the window of the apartment was kept open, and the condensed fluid which accumulated upon the floor was carried off by a waste pipe. The patients were prevented from being wet through by appropriate coverings. A suction pump outside of the chamber drew the mineral water up into a tube, which passed through a water-bath, heated to the desired temperature, and then entered into the chamber, where it terminated in a vertical cylinder, to the end of which was attached the pulverizer or apparatus for producing the spray. Six fine grooves in the cylinder, controlled by a stopcock, gave exit to as many strongly compressed streams of mineral water, which, striking with great force against a metallic plate at short range, were thence distributed in the atmosphere in the form of a fine spray.*

* *Thérapeutique Respiratoire; Traité théorique et pratique des salles de respiration nouvelles à l'eau minérale pulvérisée, pour le traitement des maladies de poitrine.* Par le Docteur Sales-Girons, Médecin-Inspecteur des Eaux Sulfureuses de Pierrefonds. Paris, 1858.

MM. Patissier and Ossian Henry visited the inhalatorium at Pierrefonds, and reported to the Academy of Paris that they were satisfied that the sprays produced at that establishment contained all the elements of the original mineral water. Sales-Girons received a silver medal from the Academy as a recognition of his valuable addition to our therapeutic resources.

Subsequently, Sales-Girons devised a portable apparatus, a *pulverisateur portatif des liquides medicamenteux*,

FIG. 16.



Sales-Girons's Pulverisateur Portatif. (From Lewin.)

a, compression pump; *b*, reservoir; *c*, stream of fluid about to strike the button which is concealed within the drum; *d*, tube with stop-cock; *f*, drum or cylinder in which the excess of spray is condensed; *g*, waste-tube to carry off the condensed fluid; *h*, manometer.

which can be used in any apartment, and through which any medicated liquid can be broken up into spray as fine as that produced in his inhalatorium.* A committee, consisting of MM. Gavarret, Patissier, O. Henry, and Poiseuille, presented a favorable report on this apparatus to the Parisian Academy of Medicine.

The convenience of such an instrument at once commended itself to those desirous of employing the new method of medication, and gave an excellent opportunity to its adherents and opponents for experiment at their convenience as to the penetration of the spray into the respiratory tract. This apparatus (Fig. 16) was manufactured by Charrière, of Paris, and is known as the first model of Charrière. It consists of a metallic vessel of the capacity of from eighteen to twenty ounces, which is to be filled two-thirds with the liquid intended to be pulverized. In the neck of this vessel there screws a compression pump (condensing syringe), which, by compressing the air above the liquid, drives the latter through a capillary tube against a convex button, in close proximity, with such force that it is from that point deflected off in a fine spray. A manometer attached to the instrument indicates the amount of pressure employed, the usual pressure being a force of from three to five atmospheres.

A second model of Charrière differs from the first in the reservoir being made of glass, and the glass tube through which the stream of fluid is forced, dipping down into the fluid.

In a third model of Charrière, water pressure is used

* *Traitemenit de la phthisié pulmonaire par l'inhalation des liquides pulvériseés, et par les fumigations de goudron.* Paris, 1868.

instead of compressed air; but, the pressure soon giving out, it requires to be kept in motion more frequently.

Later, M. Mathieu (de la Drôme) constructed a portable spray-producer according to a principle suggested by H. Tirmant, and which consists in the forcible extrusion of air and fluid at the same time. The principle will be recognized by taking an ordinary syringe after it has just been discharged of its contents, drawing back the piston, and then projecting it forward with force. The fluid remaining in the nozzle will be forcibly ejected with the escaping air, and will be converted into spray.

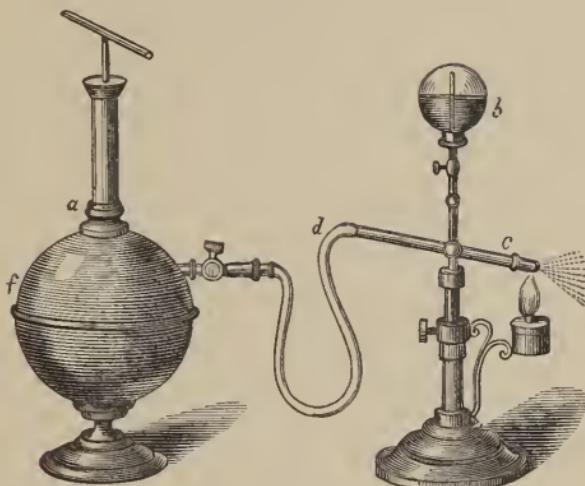
It may be mentioned, in passing, that a syringe thus handled, or the little gum-ball douches, now used for nasal, aural, and urethral injections, taking up but a drop or so of liquid and then propelling it out with great force, affords an excellent method of medicating locally the palate, tonsils, pharynx, etc. The smaller the aperture of the nozzle of the syringe, the finer will be the spray.

Mathieu's apparatus was exhibited to the Parisian Academy of Medicine on the 9th of May, 1859,* and is called by him a Néphogène, or, as properly anglicized, a nebulizer, a more correct name for these instruments than pulverizer or atomizer, the liquid being neither pulverized nor atomized, but simply broken up into a cloud or nebula. This instrument (Fig. 17) consists of a Heron's ball, in which the air is compressed. After the necessary pressure has been produced, the vent is opened by means of a stopcock, and the compressed air rushes out with great force; and, in escaping, drives before it and with it a small quantity of the desired fluid, which

* Gazette des hôpitaux, 1859, p. 297.

is allowed to drip into the exit-tube from a glass globe above; and as it leaves the capillary opening at the ex-

FIG. 17.



Mathieu's Néphogène. (From Lewin.)

a, compression pump; *b*, glass globe containing the fluid to be nebulized; *c*, exit-tube; *d*, flexible tube conveying the condensed air from the reservoir to the exit-tube; *f*, air reservoir.

tremity, it emerges to all sides in a fine spray; a lamp warms the spray as it escapes.

There are several objections to the employment of this apparatus for inhalatory purposes. A large quantity of compressed air is forced out, and the liquid is driven into the mouth in a straight line, and with such force that the ordinary strength of an inspiratory effort cannot deflect it into the air-passages, and the greater part of it condenses upon the pharynx and soft palate, and sometimes strikes these parts with such violence (according to Lewin) as to cause spasmodic closure of the glottis and excite spasms of coughing.

It is but fair to mention that this instrument was originally in-

tended for administering a local spray bath to any individual portion of the body.*

Similar instruments on the same principle have been constructed by Lambron, Velpeau, and others.

Sales-Girons also constructed a third instrument, in which the spray is produced by the agency of bristles attached to the circumference of a wheel. As the wheel is rapidly turned, the brushes dip into the fluid to be nebulized, and as they emerge from it strike with force against a ledge, whence the fluid is disseminated as a fine spray.†

Lewin, of Berlin, has constructed an apparatus with an ordinary suction pump (syringe) which forces the liquid into a reservoir, the air within which is thus compressed, and in its turn becomes a propelling force, driving the fluid, on the opening of a valve, out of a very fine aperture, whence it impinges on a convex button, and becomes thus broken into spray. This apparatus once set in action will continue to work for a considerable time without further pumping.

Waldenburg‡ has constructed an apparatus with a suction and forcing pump (the same sort of pump that is furnished with Mayer's uterine douche), which draws the liquid from a second vessel, and then drives it out, through a capillary opening, against a cylindrical drum with a concave plate of metal (*à la Sales-Girons*). A tube attached to the drum conveys the condensed excess

* See *Gaz. hebdom.*, May 4th, 1860, and, Mathieu's letter, May 11th, 1860.

† *Gaz. hebd.*, May 3d, 1861.

‡ *Die Inhalationen der zerstäubten Flüssigkeiten, etc., von Dr. L. Waldenburg, Berlin, 1864; 2d edition, 1872, under the title: Die lokale Behandlung der Krankheiten der Atemungsorgane.*

of spray back to the reservoir, so that the same liquid can be used again and again for some time. Waldenburg also conceived the idea of suspending the nebulized spray in connection with the vapor of water; and he adjusted a flask in which the water or desired decoction was made to boil, so that the steam passed through the cylindrical drum of his nebulizer and thus mingled with the spray.

Subsequently he constructed, after a plan suggested to him by Reichenheim, a chemist, an apparatus in which the steam and the nebulized fluid was produced at the same time. A convenient vessel was tightly closed by a cork. Through an opening in the cork dipped a wide tube nearly to the bottom of the vessel. The tube, gradually narrowing, terminated at its bent extremity, outside of the vessel, in a capillary opening. The vessel, filled nearly full of an aqueous solution, being heated, a portion of the liquid is converted into vapor, and, as it cannot escape through the cork, it presses more and more by its continued evolution upon the upper surface of the fluid, and in its escape drives out some of the fluid before it through the exposed extremity of the tube dipping into the vessel. Then, by directing the escaping stream against some appropriate resistance, as a convex metallic lens, the simultaneous production of steam and spray may be kept up for a considerable time.

Dr. J. Schnitzler* has constructed a special apparatus. This consists of a stout cylinder of glass, with an air-tight metallic cap and base: the air in the vessel which contains the fluid is compressed by a screw instead of a

* Wiener Medicinal-Halle, 1862, No. 29; Fieber, Lewin et al.

vertical piston, and when the cock is opened, after a few rapid turns of the screw have produced the desired pressure, the stream rushes out through a capillary tube, and impinges against a lens in close proximity. With this apparatus, the lens against which the fluid is nebulized can be held in the mouth of the patient so as to prevent too great a loss of fluid.

Fournié* has constructed an apparatus composed of a compression pump, and a reservoir with a stopcock; a glass cylinder with a tube ending in a capillary opening and made of platinum; beneath the capillary extremity of the tube, a lens on which the impinging stream is nebulized. In this apparatus, also, the lens can be inserted within the mouth, and the nebulization take place there.

The most convenient apparatus working by pressure, next to that of Lewin, to be described presently, and for promoting deep inhalations of any fluid which will not be acted upon by metal, is the modification of Sales-Girons (Fig. 18), manufactured by L. Mathieu (cutler), of Paris. It is readily managed, and produces a more minute spray than any other instrument I have seen employed.

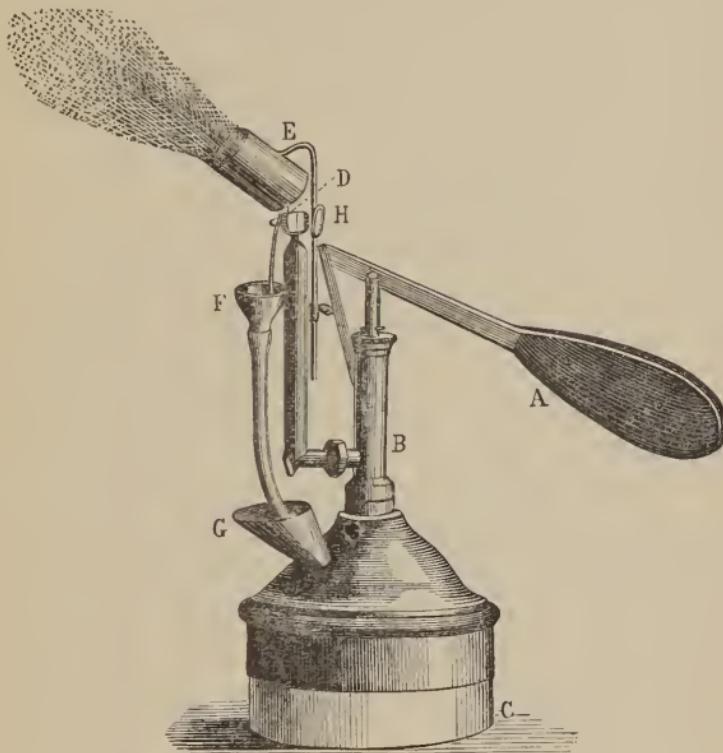
An idea of the appearance of the nebula produced may be inferred from the exclamation of a boilermaker of this city, for a friend of whom I was employing an opiate solution at ordinary temperature. He saw me take the cold water from a drinking pitcher and add it to the medicated solution, and, after watching the play of the spray for a few seconds, he burst out, "Well, Doctor, I'll be hanged! that's the first time I ever saw any one get up steam out of cold water!"

This apparatus (Fig. 18) is composed of a glass reser-

* Gazette des hôpitaux, July, 1861.

voir c, in which the liquid to be employed is poured through the little funnel g. On compressing the air in

FIG. 18.



Mathieu's Nebulizer.

A, lever; B, condensing syringe; C, glass reservoir; D, joint in which there is a groove through which the stream escapes; E, metallic drum, against the concave surface of which the stream becomes nebulized; F, waste-pipe; G, funnel for entrance of fluid; H, screw regulating the delicacy of the escaping current of fluid.

the pump B, by motion of the lever A, the fluid is forced through a small groove in one of the plates forming the joint D, and by turning the screw H, the smooth plate is more or less compressed against the groove, thus regulating the delicacy of the stream. A stream as fine as the finest hair can be thus secured if the instrument be properly constructed. This capillary stream strikes

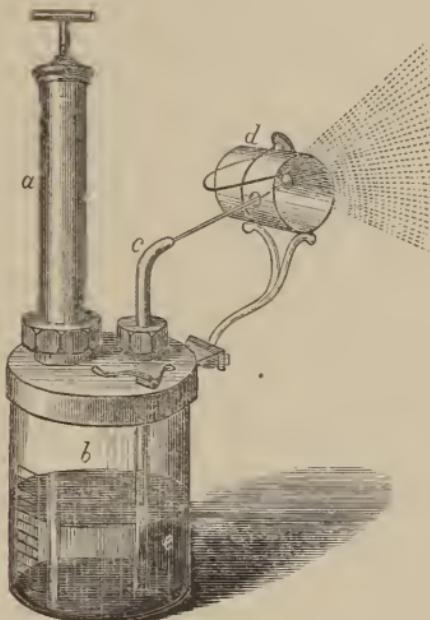
against the upper portion of the cylindrical metallic drum E, whence it is diffused in a very fine spray. A waste-pipe F, conveys the excess of fluid back into the reservoir. The force with which this little apparatus works is evident on removing the drum, when the stream will be projected up for several feet, then falling like a fountain. It is said that at a few inches distance the stream can be projected into the skin, thus forming a mode of endermic medication.

All these apparatuses are composed entirely, or in great part, of metal, which limits their employment to such articles as will not chemically react upon them.

This objection is overcome by the very admirable apparatus of Lewin, of Berlin (Fig. 19), which combines the Sales-Girons principle of the suddenly arrested stream, and the Nathanson principle of the distributing current of air. It consists of a strong glass reservoir of the capacity of one-fourth of a gallon, and is graduated in ounces. It is covered by a strong metal cap, in which there are three openings: one for the introduction of the liquid and the subsequent attachment of the condensing syringe; one affords exit to the capillary extremity of a slender tube which reaches to the bottom of the glass; and the third is covered by a spring safety-valve, through which the compressed air may escape after a certain pressure has been produced. The finger is placed upon the capillary extremity of the exit-tube until the air in the reservoir has been sufficiently compressed by a few strokes of the piston, when the finger is removed, and the fluid rushes out with great force and breaks upon a gilded metallic convex button secured in a glass drum, perforated to admit the stream, and attached by a support to the side of the instrument. The drum is

not furnished with a waste-pipe, but is so inclined that the excess of fluid will flow over its edge into any convenient receptacle.

FIG. 19.



Lewin's Glass Nebulizer. (From Lewin.)

a, condensing syringe; *b*, reservoir; *c*, exit-tube; *d*, drum.

The advantages of this instrument are, that the medicinal solution comes in contact only with glass, or with the gilded button, and therefore any substance desired can be nebulized with it; that the amount of fluid nebulized, as well as the quantity remaining, can be accurately measured; that twelve or fifteen strokes of the piston is sufficient to secure the escape of fluid for several minutes, thus avoiding the labor of frequent pumping during inhalation.

The great objection to the apparatus is its extravagance with the liquid. Where economy is no object, it

is the most convenient instrument for occasional office use. If any solution which may undergo change, or in which a precipitate may form, be allowed to remain in the reservoir, the capillary tube may become clogged up, and thus either stop the exit of the fluid entirely, or deflect the stream so that it will not impinge upon the lens. The exercise of care is necessary, therefore, to keep the instrument clean, and to avoid following its use with one medicine, by the use of another which may cause a precipitate.

Various modifications of these nebulizers have been constructed on the same principle; very few of which are ever exposed for sale in the United States. They are not much used, and have been almost entirely superseded by another class of instruments, in which steam is used as the motive power. This lack of use, however, is, in my opinion, due to a want of appreciation of their merits on the part of the profession; for they are exceedingly useful instruments, and in some classes of cases, preferable to all others.

In 1862, Dr. Bergson constructed a nebulizing apparatus according to a suggestion of Dr. Nathanson,* which depends upon a physical principle similar to that of Mathieu. This principle is, that a strong transverse current passing over a perpendicular tube will rarefy the air in the upper portion of that tube, and thus draw up any liquid in which the tube may be immersed; the liquid, as it meets the current, being broken into spray.

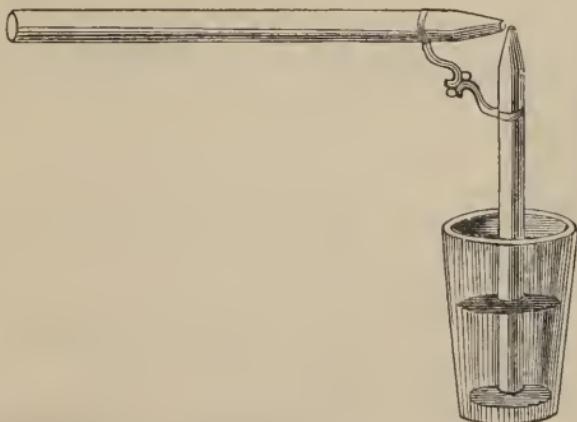
This principle was formerly applied to the cleansing of chimney flues, and more recently has been employed for pumping bilge-

* Deutsche Klinik, 1863, No. 7.

water from the holds of vessels, for distributing the water from fire-engines, and for superheating steam by the prompt evaporation of a watery spray forced within a boiler. It has of late years become familiar to almost every one in the perfume distributors used by the ladies to odorize their handkerchiefs or any other portion of their attire; and has been introduced into parlors and public places of amusement for the purpose of perfuming the atmosphere. It is also an excellent mode of distributing a disinfecting solution in the atmosphere of a sick-chamber, or the wards of a hospital.

The apparatus, as constructed by Bergson, consists of two pointed tubes at right angles, placed with their extremities together, and so joined that the extremity of the perpendicular tube should stand in front of the axis of the horizontal tube, as seen in the accompanying diagram (Fig. 20).

FIG. 20.

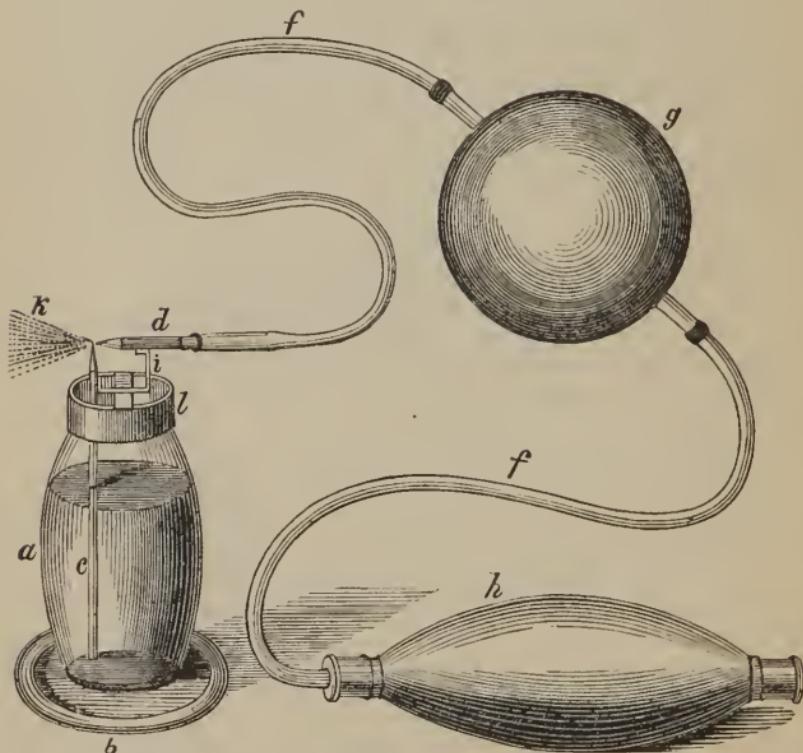


The Bergson Tubes.

If two tubes are thus arranged, and the vertical tube placed in a vessel containing a liquid, and then a current of air be blown from the mouth through the horizontal tube, the transverse current will carry over with it, as it were, the top of the column of air in the vertical tube, which, of course, will force up a current of the liquid to

occupy the space of the air; and this continuing, the liquid will at length reach the top, and be blown by the transverse current into a coarser or finer spray. The delicacy of the spray, and, consequently, its facility of ingress into the respiratory tract, will depend upon the minuteness of the extremities of the tubes, principally upon that of the tube dipping into the liquid. If the fluid is to be nebulized by the breath alone, the opening

FIG. 21.



Bergson's Apparatus with the Foot Bellows. (From Lewin.)

a, reservoir for fluid; *b*, waiter; *c*, vertical tube; *d*, horizontal tube; *f*, flexible tubing; *g*, air reservoir; *h*, rubber compressor to be compressed by the foot; *i*, joint connecting the Bergson tubes; *k*, nebula or spray; *l*, rim or cap of reservoir to which the nebulizing tubes are attached.

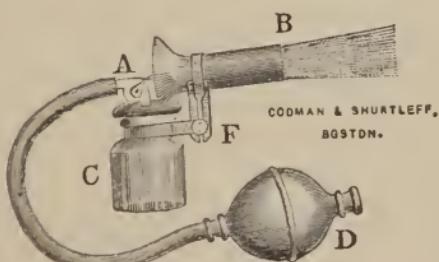
of the horizontal tube must not be too small, otherwise force enough cannot be produced. If the current is

produced by means of a bellows, as the bulb of Davison's injecting syringe, the opening of the horizontal tube can be smaller.

For the production of a continuous stream, an air reservoir must be attached to the tubing; and, for this purpose, Dr. Bergson adopted the arrangement of a rubber bellows worked with the foot, connected to the horizontal tube by rubber tubing, in the continuity of which is placed a globular elastic ball as an air reservoir (Fig. 21).

Later, Dr. Andrew Clarke, of London, adopted smaller bulbs, so that they can be compressed by the hand. It seems to me that the main advantage of the double bulb is, that pumping is thus rendered less laborious, for I do not conceive that there is anything to be gained for purposes of inhalation by the production of a continuous stream; at times, indeed, rather the reverse, for the expiratory current regularly interrupts the inhalation necessarily, and may thus cause a waste of fluid.

FIG. 22.



(Modification of) Clarke's Nebulizer.

A, nebulizing tubes; B, mouth speculum; C, bottle for medicated solution; D, rubber hand-compressor; F, joint permitting the mouth speculum to be removed, or turned aside.

A convenient arrangement for hand-use is shown in Fig. 22.

Dr. G. J. Arnold, of Roxbnry, describes* an apparatus in which he employs hydrostatic pressure as the propelling force. The horizontal tube of a Bergson apparatus is connected with the upper portion of an air reservoir by means of a stopcock and rubber tubing; another reservoir filled with water is placed at a higher elevation; as the water from the latter flows into the lower portion of the air reservoir, the air within it is compressed, and when sufficient pressure has been obtained, the stopcock is opened, and the compressed air escaping through the horizontal tube produces the nebulization.

It is not often that it is requisite to administer inhalations in one's office; but where this is done a great deal, it has been found advantageous by some practitioners to employ a pneumatic reservoir, into which air is compressed by hand or steam, and kept under pressure so that it can be used at will. This saves the trouble of pumping during the use of the apparatus. Compressed oxygen, or compressed carbonic acid gas, may be kept in reservoirs for the same purpose in cases where the employment of these gases is deemed advisable. I have used all these methods, at times, for nearly ten years, and find them very convenient, though their employment, in my own practice, is chiefly restricted to using the sprays as douches to cleanse the pharyngeal and laryngeal surfaces from mucus previous to making topical applications. The use of the carbonic acid gas I have long abandoned, but still continue the use of compressed air and oxygen.

A young French physician, whose name has escaped my recollection, first employed carbonic acid gas (in 1867, I think) by

* Boston Med. and Surg. Jour., Dec. 27th, 1866, p. 434.

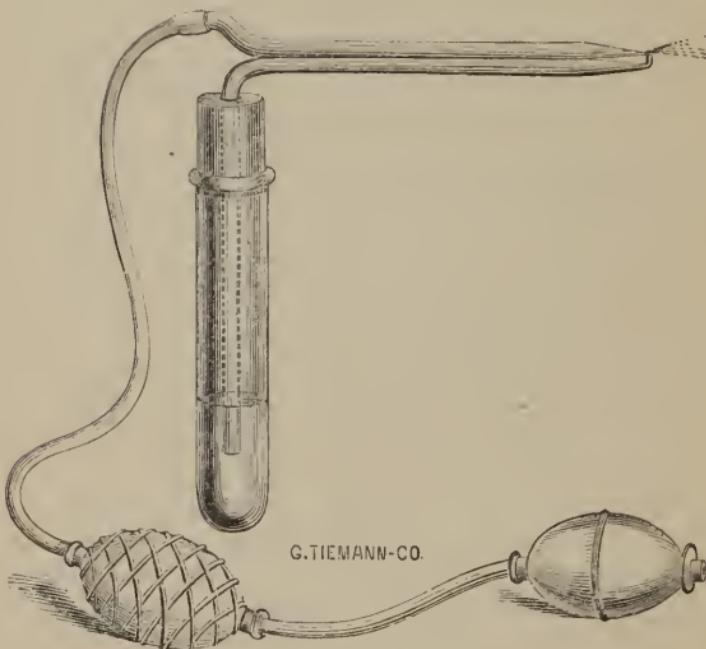
evolving it, as required, from a mixture placed in a vessel to which the horizontal tube is attached; much in the same manner as now used for extinguishing fires by the gas.

The tubes used in these nebulizers can be constructed of metal, glass, or hard rubber. Glass tubes can usually be cleansed by an acid bath, or by nebulizing through them a dilute mixture of sulphuric or muriatic acid and water, and then soaking them in pure water. If they become clogged, the best way to free them is by suction with the mouth at the larger end, so as to draw the obstructing matter back from the small end of the tube. If this does not suffice, or they become clogged while in use, a camel's-hair pencil, or a bristle, or a fine metallic wire, may be employed. A needle will be apt to break off the fine points. The tubes may be formed by drawing out glass tubing over the flame of a spirit or gas light, and then separating them by a scratch with the blade of a knife; and if they are so joined that the points bear the relation to each other, shown in Fig. 20, they will work satisfactorily. If the end of the perpendicular tube be below the axis of the horizontal tube, the current will pass over it without impinging sufficiently to take the head off of the air in the vertical tube; and if it be too high, the current will pass to the side, or perhaps pass down the vertical tube, and cause the fluid to bubble up in the vessel. If the perpendicular tube be bent so as to run under the horizontal tube before dipping down into the liquid (see Fig. 27), the tubes can be nicely adjusted by cord or small sections of gum tubing. I had been in the habit of forming tubes in this manner for some time before I became aware that the modification had already been adopted by Prof. Winterich, of Berlin, and for the same purpose, that of gaining readier access within the cavity of the mouth. Indeed, the idea soon suggested itself to everybody of turning these tubes, after properly adjusting their points, so as to gain access to any desired point; and they have been curved into douches for the nares, anterior and posterior, the Eustachian tubes, the larynx, the bladder, the uterus, etc.

The neatest nebulizing tubes I have seen are those originally made by Dr. Sass, of New York, for his own use, some years ago, and of late years furnished by most vendors of surgical instruments. They are made of strong glass, firmly cemented, the surfaces of contact

having previously been ground flat so as to secure firmer adhesion. The nebulizing tubes are inserted into tubular reservoirs (Fig. 23), conveniently held in the hand when making the applications. A long personal use of this form of tube (a number of which, with tips turned in the various directions for applications to the larynx and the upper pharynx, were presented to me by Dr. Sass), has been in every way satisfactory.

FIG. 23.



Dr. Sass's Horizontal Nebulizer, with Tubular Reservoir.

Dr. Lewin has devised a very convenient pocket nebulizer after the pattern of Bergson. The rectangular tubes are made of metal or of vulcanized rubber, and joined by a hinge, so that when not in use the two tubes fold one upon the other, and take up but very little space. This is intended for use, as occasion may require, by blowing through the horizontal tube with the breath; but such a method is rather applicable to other purposes than those of inhalation, for the idea of another's breath being blown into one's mouth is disagreeable. To those who care to employ this method

I would suggest the attaching of a few inches of rubber tubing to the horizontal tube, so as to avoid close contact with the face of a patient, and to render the necessary effort less laborious.

Dr. Mans* has made an improvement on the construction of these tubes of Bergson, which I have found to give at each compression of the pump, or hand-compressor, an amount of spray almost incredible to one who has not witnessed it; and this with very little effort. This effect, though not more advantageous than the original tubes for purposes of inhalation, inasmuch as these latter produce spray enough, I have found extremely useful in cases of pharyngitis where I wished to employ the spray as a substitute for the gargle; and this especially in the throat troubles of young children, where the instrument which will do the most service in the shortest space of time is quite a desideratum.

In this modification, the apparatus is made out of three tubes instead of two. The third tube communicates with the horizontal tube, and runs down behind the perpendicular tube the depth of a cork, in which the two vertical tubes run. Now, when the medicine vial is tightly corked, part of the transverse current presses on the surface of the liquid, and forces it up the perpendicular tube which dips into it, and thus the force that in the original tube is exhausted in producing the vacuum in the vertical tube, is reserved for the production of spray. I have had instruments thus arranged, duck-billed, after the manner of Winterich, and then curved so as to point to any desired portion of the pharynx, the whole of which, if desired, can be doused by a single pressure of the bulb.

The spray producer of Dr. B. W. Richardson, of

* Deutsche Klinik, June 16th, 1866, p. 224.

London, introduced for purposes of local anaesthesia, is constructed upon the same principle as Mans's modification of Bergson's tubes, but upon a different model. In both Mans's and Richardson's instrument the pressure continues for some moments after each compression of the bulb, which is not the case in the Bergson tube.

Bergson has named his apparatus a *Hydrokomion*, the same name applied in 1829 by Schneider and Rudolf Walz to a sort of shower-bath apparatus, consisting of a reservoir containing water, the air over which was compressed by a pump, the fluid being driven out through many fine openings. This last-mentioned apparatus, however, was never intended for inhalatory purposes.

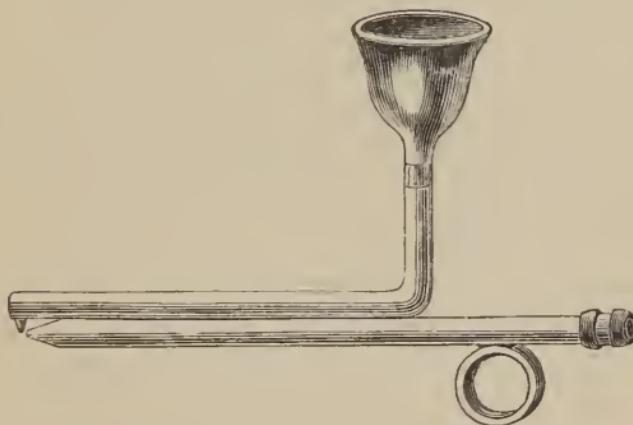
The nebulized current from the Bergson apparatus is more powerful than that from apparatus on the Sales-Girons principle, and it can be at once directed into the mouth. It is therefore most suitable to diseases of the palate, pharynx, base of tongue, and lingual surface of the epiglottis. For the deeper structures, the other instruments, the spray from which merely hangs suspended in the air, are more suitable, as they are less likely to elude the current of inspiration.

Lewin, in conjunction with Bergson, constructed an attachment to his apparatus already described, by which the same instrument could be employed on the Bergson principle, and thus answer every indication. The drum and lens is removed from the apparatus (Fig. 19), and a rod and rings are attached, so as to support a graduated glass tube, terminating below in a very fine opening, placed directly in front of the capillary opening of the tube dipping into the reservoir. The glass tube is filled with the solution to be nebulized, which drips by gravity in front of the other opening. The reservoir contains nothing but air, and as this is compressed, the current

escapes, and the nebulization is thus produced. It is really Bergson's tubes, upside down.

In May, 1865, I exhibited to the Surgical Section of the American Medical Association a portable silver instrument (Fig. 24), in which I had turned the Bergson tubes, as modified by Winterich, upside down, and screwed a little reservoir on to the large extremity of the perpendicular tube, so as to make use of the same principle of gravity. Where glass tubes are

FIG. 24.



Bergson's Tubes reversed, with the reservoir on top.

employed, the extremity of the perpendicular tube is blown out into a reservoir (see Fig. 27). If the fluid drips down too fast,—and that it will drip is an objection to the instrument, rendering its employment inelegant at certain times,—it can be regulated by the insertion of some porous material, or, in the metallic reservoir, by diminishing the size of the opening through which the fluid drops into the tube. This instrument is very useful in many cases. Patients can manage it themselves; if of glass, can readily adjust the extremities of the tubes

so they will work; and in applying nebulized fluids to the pharynx, etc., the vessel containing the fluid does not obstruct the view into the mouth.

In all these apparatuses thus described, with the exception of the Reichenheim-Waldenburg instrument, the spray, as it emerges, is too cold for general use in acute affections, unless the fluid employed is first warmed, or the spray produced and passed over a spirit-lamp, as in the apparatus of Mathieu, Fig. 17.

It was, therefore, a happy idea of Dr. Siegle, of Stuttgart, to employ steam instead of compressed air, as the motive power with the Bergson tubes, thus saving to the patient the necessity of an assistant, or the labor of frequent pumping; and securing a more constant nebulizing force than can be produced by the pump, from which the force gradually diminishes unless periodically renewed.

Siegle attaches the horizontal tube to a small boiler. Underneath this boiler is a lamp. The boiler being partially filled with water and the lamp lighted, steam is evolved, and as it escapes through the tube, it creates the transverse current necessary to draw the fluid from the reservoir up the perpendicular tube, and then nebulizes it in the manner already described. The only possible objection to steam as a motive power is that the nebulized fluid is always mixed with a certain amount of vapor of water, which it is possible, but hardly probable, might sometimes prove objectionable. The largest portion of the steam escapes in the surrounding atmosphere; very little is mixed with the spray; too little to prove objectionable. How small this quantity is will appear in the sequel.

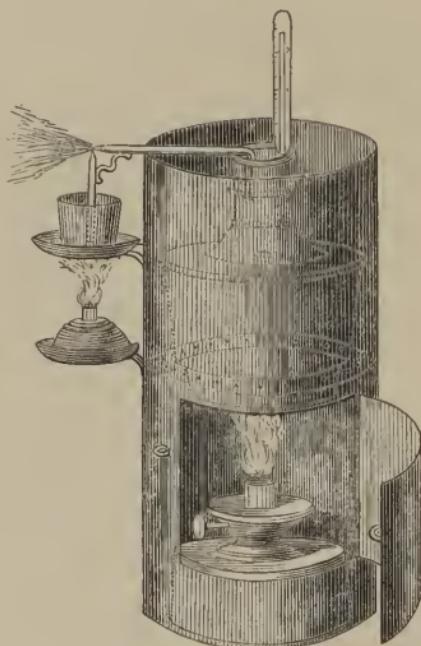
Siegle's boilers are made either of metal or of glass;

and each one, before it leaves the manufacturer, is tested to bear a pressure of at least two atmospheres. The boiler is furnished with a safety-valve to avoid explosion, and with one of Collardeau's thermo-barometers, gauged to two atmospheres, in order to indicate the pressure, which is regulated by raising or lowering the flame of the lamp by means of a screw acting on the wick. A stand sliding on the outside of the apparatus sustains the reservoir of the fluid to be nebulized by it; and below this, another stand supports a small spirit-lamp, in order to raise the temperature of the liquid in the vessel above if necessary. For office use the apparatus may be furnished with a gas lamp, which is more convenient and less expensive, and a large boiler can be made to receive several sets of the Bergson tubes, so that separate tubes may be employed for nebulizing such solutions, as of tannin, chloride of iron, etc., which are likely to form precipitates with other solutions.

The most convenient form of Siegle's apparatus is that figured in the accompanying cut (Fig. 25); the whole closed in a metallic case, which still further lessens the danger of bad results from an explosion. The horizontal tube passes down by an elbow into the boiler through a tightly fitting rubber stopper; and the cork stopper in the opening through which the water is introduced does away with the necessity of any further safety-valve. The thermo-barometer is gauged to two atmospheres, but the apparatus will be set in action with a pressure of one-half atmosphere. The stronger the pressure, the more rapid the escape of steam, the more rapid the nebulization, and the stronger the propulsion of the spray. The desired pressure can, therefore, be readily

maintained by controlling the height of the flame beneath the boiler.

FIG. 25.



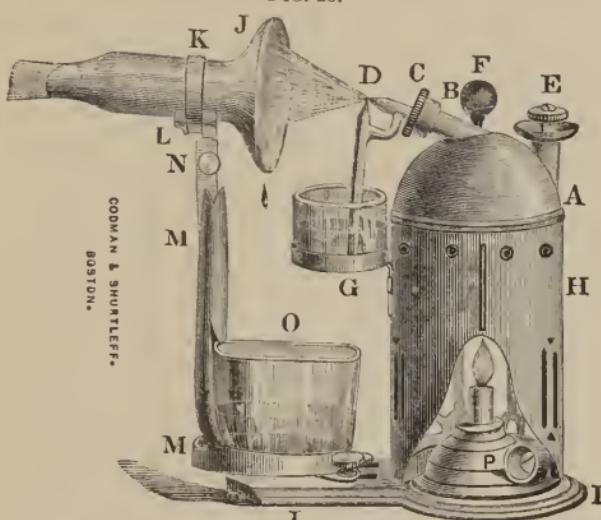
Siegle's Steam Nebulizer.

Various modifications of Siegle's Steam Hydrokomion have been made by Lewin, Fieber, Burow, Pissin, Beigel, and many others; but they are all on the same principle, and possess no advantage over his.

Messrs. Codman & Shurtleff, surgical instrument makers of Boston, manufacture a very efficient and convenient form of this apparatus (Fig. 26), which has almost entirely superseded all the other instruments of the kind sold in the United States. It is carefully made, each boiler being thoroughly tested before leaving the manufactory, and it is supplied at a moderate price. This is the apparatus which for several years I have been in the habit of recommending to my patients, not-

withstanding my dislike to recommend patented instruments.

FIG. 26.



Codman & Shurtleff's Steam Nebulizer or Spray Producer.

A, boiler; B, steam-pipe; C, packing-box; D, nebulizing tubes; E, safety-valve, closing funnel-shaped orifice for pouring in water; F, wooden handle, for removing boiler from the stand, etc.; G, socket for medicine cup; H, support for boiler; I I, base; J, glass face shield; K, elastic band, fastening face-shield to L, cradle; N, mill-screw, to raise or lower face-shield; M M, support for face-shield; O, waste-cup.

The only suggestions I have to make to complete this apparatus, and the remark applies to all of the same class, is that the boiler should be provided with a water-gauge, and be arranged so as to admit of proper cleansing. An instrument of the kind, supplied with a water-gauge, has been made for me by Messrs. Codman & Shurtleff, and I find it of great service in indicating the quantity of water in the boiler.

In all these forms in which the horizontal tube is bent so as to dip down into the boiler, every now and then, especially soon after the apparatus is set in action, the steam condenses at the curve, and as this is driven out by the stream behind, it spouts out hot water, which is

sometimes projected into the face or eyes of the patient with very unpleasant results, and sometimes renders them unwilling to continue the inhalation. This can be in great measure avoided by passing the horizontal tube directly into the boiler at the side close to the top, and thus avoiding the curve where the steam condenses. This is the form of instrument that I prefer, with the duck-bill form tubes, which permit of their being introduced within a mouth speculum, and thus avoiding considerable loss of spray. No safety-valve is considered necessary, inasmuch as an excess of steam would force out the cork, and thus escape without explosion. With this modification, the apparatus, originally constructed for myself in 1865, by Wilhelm & Newman, of Philadelphia, as figured in the following cut (Fig. 27), is

FIG. 27.



Modified Form of Siegle's Steam Nebulizer, with Duck-bill Tubes.

essentially the Siegle apparatus, having his original arrangement of a lamp with a screw for raising or lowering the wick. A glass speculum, introduced well into

the mouth, protects the teeth, tongue, roof of the mouth, etc.; and the tubes entering the funnel end of the speculum, the face and clothing are thus protected, a very desirable precaution in the inhalation of solutions of the nitrate of silver and the like. The condensed liquid, as it flows over the funnel extremity of the speculum, is directed into an appropriate receptacle, so as to protect the clothing and furniture. The instrument, with all its appurtenances, has long been supplied by Mr. Germrig, the well-known surgical instrument maker, of Philadelphia.

When the medicated solution is allowed to drip, as from the tubes figured in the upper portion of the illustration, the spray is much coarser and more abundant, and much more suitable in the treatment of affections of the pharynx, especially those in which an insufflation or a douching is desirable rather than inhalation.

Some of the face protectors have a tubular offset below, to which a piece of flexible tubing can be attached, and thus act as a waste-pipe to direct the excess. A very convenient combination of this kind, with the funnel or face protector attached to the apparatus, has been constructed by Dr. William Read, of Boston, which is very compact, and can be readily carried about securely packed in a tin box employed as a stand when the instrument is in use.

Dr. Beigle, of London, also, has constructed a very useful face protector, a sort of concave plate, with a central aperture through which the spray passes, to be placed in front of the mouth of the patient.

Dr. Beigle has also devised an admirable little pocket steam apparatus, suitable for travellers who desire to continue this method of medication.

Lewin, Burow, and some others, prefer the horizontal tube to be of metal, with a holder, in which slides the glass tube intended to dip into the medicated fluid. This is an improvement, as the risk of breaking the horizontal tube is avoided ; and if the glass tube become broken it can be readily replaced by another, and easily adjusted.

A FEW REMARKS are necessary concerning the individual advantages of the different varieties of nebulizing apparatus described.

The steam nebulizer will fulfil the greatest number of indications. The spray being mingled with steam can, when inhaled at a distance, be drawn into the minuter ramifications of the bronchial tubes and into the pulmonary vesicles ; and the temperature of the spray can be maintained, when desired, at a moderate warmth.

Hand-ball nebulizers, and all those working by compressed air or compressed gas, are not suitable for purposes of inhalation as much as for insufflation or douching—that is to say, the force of the spray is such that little or none of it gets access into the lungs without great effort on the part of the patient. Besides this, no matter how warm the medicated fluid may be in the reservoir, heat is evaporated so rapidly when it is converted into spray that the temperature of the nebula is always very low, often too low to be employed at all ; and therefore unsuitable for use in many affections, and actually injurious in some. My own opinion is that the promiscuous use of this form of apparatus has done more than anything else to prevent a proper development of the method of local therapeutics under consideration.

The class of instruments first invented (by Sales-

Girons and by others, on the same principle), and which, strangely enough, are almost entirely unappreciated in this country, furnish a spray which is not mingled with either compressed air or steam ; a spray which can be readily maintained at almost any desired temperature by using warm or hot medicated solutions ; a spray which plays so gently in the atmosphere that it can readily be inhaled, mingled with the normal inspiratory current, without special effort on the part of the patient.

It is thus obvious that, under certain conditions, each variety of apparatus best fulfils a distinct indication.

EXPERIMENTS UPON MEN AND ANIMALS AS TO THE PENETRATION OF NEBULIZED FLUIDS INTO THE RESPIRATORY PASSAGES.

The report of Sales-Girons to the Academy of Medicine of Paris, as to the results obtained in his inhalatorium, caused considerable sensation in medical circles ; and numerous experiments were instituted under different auspices, and with certain predilections in favor of the new method or against it, to determine whether the nebulized fluids really penetrate into the respiratory tract, and if so, to what extent.

At first the number of these investigations was limited, because the experiments had to be carried on at the establishments where the method was being employed ; but as soon as Sales-Girons devised his portable instruments, investigation was further stimulated, and being rendered more convenient of execution, a great number of observers became engaged in the pursuit. The results of these experiments were duly published in the leading French journals, and, as the subject spread outside of

France, in other European journals. They have been recorded with more or less detail in the works of Waldeberg,* Fieber,† Lewin,‡ and others, and alluded to by every one who has written on this subject. As they are interesting, instructive, and suggestive, we will repeat the account of them given in the first edition of this volume.

EXPERIMENTS WITH NEGATIVE RESULTS.

Prominent among observers reporting negative results, was Prosper de Pietra-Santa, physician at Eaux-Bonnes, whose experiments were performed, in an inhalatorium arranged at Eaux-Bonnes, according to the principles of Sales-Girons, and partly in the presence of Poggiale, who had been appointed by the Academy to prepare a report on the subject.

He experimented upon a goat, upon three rabbits, and upon himself and another observer.§

He caused a young goat to breathe, for a quarter of an hour, an atmosphere loaded with the nebulized mineral water of Eaux-Bonnes, to which a small quantity of common salt had been added. The animal was then killed, and a solution of nitrate of silver applied to the larynx and bronchi, but without evincing any reaction.

He caused a rabbit to breathe a nebulized solution of

* Op. cit.

† Die Inhalation medicamentöser Flüssigkeiten, etc., von Dr. Friedrich Fieber, Wien, 1865.

‡ Die Inhalations-Therapie, etc., von Dr. Georg Lewin, Berlin, 1865.

§ L'Union médicale, 1861, Nos. 43, 44, and 59; Gazette médicale de Paris, 1861, Nos. 14 and 15.

sulphate of iron from the Sales-Girons apparatus, for a period of twenty minutes. The application of a test of cyanide of potassium failed to detect any iron in the lungs or in the larynx ; but succeeded in the isthmus of the throat, on the soft palate, and in one portion of the oesophagus ; the latter probably because the animal had swallowed some of the fluid.

He held two rabbits within a short distance of the spot where the fluid was nebulized in the inhalatorium of Eaux-Bonnes. The animals were killed, and the test applied with nitrate of silver and with acetate of lead, but without evincing the slightest trace of reaction in the respiratory organs.

M. Prosper de Pietra-Santa read his memoir before the Academy of Medicine, October 8th, 1861,* coming among other conclusions, as the result of his clinical observations and experiments, to the following : that the nebulized mineral waters do not penetrate into the bronchi ; that a considerable depression of temperature is produced at the moment of nebulization ; that a very considerable desulphurization takes place in the nebulization of these mineral waters ; and that the temporary alleviations observed, are due to the inspiration of the disengaged hydro-sulphurous gas.

Rene Briau, physician at Eaux-Bonnes,† at the laboratory of the College of France, placed at his disposition by Prof. Claude Bernard, on 31st January, caused a rabbit to breathe for twenty-two minutes close to the drum of a Sales-Girons apparatus, the nebulized spray of two litres (a litre is 1.0567 quarts) of a solution of cyanide of potassium ; the animal remaining tranquil and breath-

* Gazette hebdomadaire, 1861, p. 659.

† Id., No. 15.

ing the whole of the liquid. Immediately after, the animal was killed by section of the spinal cord. The test of a solution of the sesquichloride of iron was applied, and detected the presence of the cyanide salt in the larynx, in the trachea, and in the larger and smaller bronchi. Prof. Claude Bernard, who, with MM. Vella and Leeonte, witnessed this experiment, raised the objection that the substance employed is very readily and very rapidly absorbed into the blood, and that this fact could account for its presence in the respiratory tract; and, at his suggestion, the urine, ureters, and kidneys were also tested, and the same reaction took place. Briau, therefore, did not consider the experiment conclusive. Lewin,* in commenting upon this experiment, very pertinently observes that the absorption into the system might have taken place through the delicate mucous membrane of the respiratory organ.

Then reversing his experiment, Briau caused a rabbit to inhale a solution of the chloride of iron (a salt absorbed with difficulty by the animal tissues) during twenty-six minutes; and the reaction gave again a positive result.

The 6th of February following, a small dog was held close to the drum and breathed tranquilly, for twenty-five minutes, an atmosphere in which two litres of the solution of the perchloride of iron was nebulized. In this case the test could detect no trace of the salt except in the mouth, the nostrils, and the pharynx. He then performed the same experiment with another dog, employing the solution of the cyanide of potassium by inhalation, and the iron salt as the test. Surprised at the

* Op. cit., p. 163.

different results on two species of animals, so closely related, he immediately repeated his experiments upon another rabbit, and on applying the test, in a few minutes the characteristic reaction occurred in the whole extent of the bronchial tract.

Finally, Prof. H. Bouley (d'Alfort) placed at his disposal a horse, which had a carcinomatous tumor of the stomach; and on the 18th of February, with the assistance of M. Raoux, he experimented on this animal at the veterinary college. The horse, whose respiratory organs were intact, was placed horizontally, with his head on the same plane as the rest of his body. The experiment lasted an hour and a quarter, forty-five minutes being consumed in the inhalation of four litres of a solution of the sesquichloride of iron. After the animal was killed by section of the spinal marrow, the fluid which had been inhaled was detected in the nostrils; but there was no evidence of its having penetrated into the bronchi, the trachea, or the larynx. Briau concludes that he can account for the success with the rabbits on account of the proximity of their glottis to the mouth, and that the fluid in condensing on the posterior walls of the pharynx flows down into the larynx and trachea. In this view he is sustained by Prof. Claude Bernard.

Champouillon* directed an invalid to breathe, for half an hour, a solution of the chloride of iron. After the mouth had been thoroughly rinsed, the sputa were tested with cyanide of potassium, but no reaction was produced.

Delore† caused several individuals to inhale nebulized

* *Gazette des hôpitaux*, 1861, No. 66.

† *Gazette médicale de Lyon*, 1861, September 1st and 16th.

solutions containing iodide of potassium and tincture of iodine; but found no trace of iodine either in their urine or in their saliva.

Armand Rey* desired to employ an atmosphere more profusely loaded with spray or nebula than could be produced by the apparatus of Sales-Girons, and he constructed an apparatus by means of which the capillary jets of water, projected by a vertical pressure of fifteen metres, were received perpendicularly upon the palettes of a horizontal turbine, very rapidly rotated in the direction opposite to that of the jets. He thus produced a very dense spray, but the whole of the water did not nebulize; a portion of it spurted about unpleasantly. To control this dashing he enclosed the apparatus in a wide-meshed net, but to his astonishment it caught the whole amount of the spray, which it condensed, and did not permit the slightest particle to pass through. Then he employed pasteboard, in which he made openings of the size and form of the human glottis, and again the whole of the spray was caught and condensed.

After this he instituted some experiments upon animals, the results of which were negative.

The cause of these obstructions he attributed to the circumstance that these sprays are merely suspended in the air, and that therefore, as soon as any impediment interfered with their slight impulse, the nebulized particles immediately collected and condensed into drops. Thus the inner surface of the cheeks, the roof of the mouth, palate, etc., being such impediments, they detain the spray, which falls in drops without gaining entrance into the larynx. But, as Lewin observes, he seems to

* Union médicale, 1861, No. 139.

have overlooked the fact that in inhalation the inspiratory current, as it passes into the lungs, will deflect these light particles as they play in the atmosphere, and direct them towards the middle line of the open glottis, so that they will describe a sort of curve in their passage.

Edouard Fournié was the most persistent opponent to the new method, and exercised a remarkable degree of ingenuity in devising crucial experiments to put to the utmost test the theory that the nebulized medicaments penetrated into the air-passages.*

At a séance of the Académie des Sciences, held September 16th, 1861, he read extracts from a work of his, entitled, "Mémoire sur la pénétration des corps pulvérulents, volatils, gazeux, solides et liquides, dans les voies respiratoires au point de vue de l'hygiène et de la thérapeutique," in which he details his various experiments.

In order to test the mechanical feasibility of such penetration, Fournié constructed an artificial respiratory apparatus. He bent at right angles a tube twenty-five centimetres long and two centimetres in diameter, and placed it through one of two openings in a flask, so that it dipped into a solution of sulphate of iron, with which the vessel was half filled. The free extremity of this tube terminated in a wide mouth-piece, which might represent the oral cavity. The other opening communicated, by means of rubber tubing, with the nozzle of an exhausting syringe, furnished with a delicate valve, which would open as soon as the force exceeded that of the inspiratory force of the lungs of a strong healthy man. He filled a Sales-Girons apparatus with a solu-

* Proceedings of Académie des Sciences, 1861; Gazette hebdomadaire, 1861, p. 626; Gazette des hôpitaux, 1862, No. 9.

tion of the cyanide of potassium, and placed it at ten centimetres distance from the mouth-piece of the apparatus; and at the same time that the nebulizer was put in action, the exhausting syringe was placed in motion rhythmical with the duration and strength of ordinary human inspiration.

Although the fluid was thoroughly nebulized, the solution of sulphate of iron did not change color in the least. From this experiment Fournié came to the conclusion that he had demonstrated that the solution of the cyanide of potassium could not be made to enter the flask.

At a later date he instituted a different experiment. Having detached from a recent cadaver, a human larynx with the tongue, epiglottis, and pharynx, he attached to this a glass tube of the diameter of the trachea. Artificial inspiration was produced by placing in the mouth of the experimenter a tube of rubber attached to the lower end of the artificial windpipe; and during the inspiration, the glottis was held open by means of *serres-fines* attached to the posterior crico-arytenoid muscles, while the watery spray from the pulverisateur was directed towards the larynx. It was seen in this experiment that the larger portion of the nebulized fluid struck on the pharynx, and was then and there condensed. Another smaller portion fell down upon the epiglottis, which protected the opening of the glottis like a regular roof, and thence glided in great drops along the aryteno-epiglottic folds to gain entrance into the larynx. Not the slightest trace of the nebulized water could be seen upon the walls of the tube.

This experiment was repeated with solutions sensitive to the most delicate chemical tests, and with similar negative results.

Then Fournié experimented on himself. He took it for granted that if the nebulized fluids penetrated into the trachea and the bronchi, he ought to be able to detect their presence in the sputa expectorated immediately after an inhalation. Suffering at the time from an acute attack of bronchitis, he inhaled a solution of arsenious acid, five centigrammes to five hundred grammes of water. He selected this material because it is less readily absorbed through the tissues than others, and, at the same time, can be detected by reagents when present in the minutest quantity.

He placed himself within five centimetres distance from the opening of the apparatus, and inhaled, to the best of his ability, with widely opened mouth, the entire solution of five hundred grammes. The matters expectorated during the few minutes next succeeding, and amounting to four grammes, were dried upon a platinum capsule, incinerated with nitrate of potassium, and the product of combustion placed in contact with water acidulated with sulphuric acid, according to the process of Marsh ; but without producing any of the metallic arsenical rings on the porcelain. The reaction ensued, however, as soon as one drop of the arsenical solution was added.

A similar experiment, performed upon a young man laboring under a profuse specific bronchorrhœa, afforded the same negative result.

On another occasion a concentrated solution of nitrate of silver was inhaled through a glass tube of three centimetres diameter, employed in order to protect the mouth from discoloration. Laryngoscopic inspection, immediately after the inhalation, showed the posterior wall of the pharynx tinged with the nitrate ; but the interior of

the larynx retained its natural color. The sputa expectorated immediately after, showed no evidence of the inhalation.

A young man, twenty-four years of age, who had worn a canula for several years, in consequence of a fracture of the larynx, the result of an accident, was selected for an experiment. The condition of the young man's organs, as seen by the laryngoscope, was as follows: Above the vocal cords, everything appeared normal; the cords themselves were colored red, having lost their brilliant mother-of-pearly tint; toward the posterior inferior third of the left vocal cord a small nodule was perceived, having much the appearance of a cartilage. The lesion had not interfered with inspiration, for the arytenoid cartilages separated properly and the laryngeal cavity expanded in the usual manner; but expiration was so difficult that for its performance the tracheal opening was indispensable; the closure of the larynx during expiration seemed to be effected by the lesion in the cricoid cartilage, which had been the seat of fracture, as a result of which the crico-thyroid and posterior crico-arytenoid muscles had become paralyzed. A bunch of raw cotton attached to a thread was introduced into the trachea, and the pulverisateur set in action. During the inhalation the canula was closed by the finger of the patient, which was slightly raised during expiration; and the solution employed was of iodide of potassium five grammes to five hundred grammes of water. After the inhalation, the cotton was withdrawn and tested with starch and with sulphuric acid, but afforded no reaction.

A similar experiment was performed upon one of the female nurses of the Hospital Beaujon, who also wore a canula in her trachea, and with the same negative result.

From these experiments, Fournié offered the following reasons to account for the non-penetration of the nebulized liquids :

1st. The divergence of the watery particles in issuing from the apparatus.

2d. The propulsion of the current from the apparatus in a straight line.

3d. The curve of the trachea.

4th. The proximity of the soft palate to the base of the tongue.

5th. The involuntary contraction of the glottis.

6th. The irritability of the larynx.

Finally, he draws the following conclusions :

1st. It is nevertheless possible, by this method, to induce a toxic effect upon the larynx, but one of short duration only.

2d. The fluid can certainly penetrate into the air-passages, but not with facility, nor in sufficient quantity ; and this only when the inhalation is performed with peculiar care, such as opening the mouth well, separating the base of the tongue from the soft palate, with the head inclined backwards to destroy as much as possible the rectangular curve that the windpipe makes with the oral cavity.

In contradistinction to the difficulty or impossibility of inhaling fluids into the air-passages, he calls attention to the facility with which solid powders can be drawn by inspiration even into the remotest bronchi, in proof of which he cites the various experiments in which he demonstrated that such powders will pass completely through a tube twenty-five centimetres in length and two centimetres in diameter, and bent at a right angle ; and he says that while the watery particles condense upon

the sides of the tube, solid particles are propelled by successive ricochetting to the very end of the tube.

Fournié believed the sulpho-hydrogen gas, disengaged from the thermo-sulphurous waters, to be, by its direct contact with the seat of lesion, one of the principal agents in the cure of diseases of the chest.

Lewin, in commenting upon these experiments,* calls attention to the circumstance that Fournié seems to have overlooked the important fact that the trachea and the bronchi, instead of being dry and smooth like the glass tubes used for experiment, are constantly moist, and more or less covered with mucus; and that the pulverulent particles must possess a peculiar strength if they can ricochet over this moist mucus until they reach the bronchi.

If powders penetrate into the bronchi they must be projected in a continuous line, for as soon as they alight on the moist surface they must become entangled and remain there.

As Lewin says, in ignoring as conclusive Fournié's experiment with the exsected larynx, in which the epiglottis is placed "like a regular roof over the entrance of the glottis," the epiglottis does not retain this position during deep inspiration, as can be demonstrated by laryngoscopic observation; it becomes more erect. It is absolutely impossible to place the larynx of a cadaver with its pharynx, soft palate, tongue, etc., in the position which they assume during life in deep and voluntary inspiration.

EXPERIMENTS WITH POSITIVE RESULTS.

The most extensive series of experiments were per-

* Op. cit., p. 174.

formed by Demarquay, surgeon to the Maison Municipale de Santé; and these it is, principally, upon which is based the favorable report to the Académie de Médecine.*

These experiments were performed at the Maison Municipale de Santé in the presence of Profs. Poggiale, Réveil, Gobley, and Troussseau, MM. Mialhe, Sée, Pic-tria-Santa, Giraud-Teulon, and the students of the institution; and with the assistance of M. Leconte.†

Demarqny experimented upon some eighty rabbits, upon a number of dogs, and upon the same female nurse at the Hospital Beaujon, who was made the subject of one of the experiments of Fournié.

The rabbits were caused to breathe an atmosphere loaded with the nebulized spray of a solution containing one gramme of the perchloride of iron to one hundred grammes of distilled water, the apparatus employed being that of Mathieu (and Tirman). The snouts of the rabbits were held forcibly open by a suitable dilator. The experiments continued five minutes, with a few momentary intervals of rest. The animals had all been lively before the experiment; a number of them were killed immediately upon the conclusion of the experiment, and the remainder were saved. Upon testing the respiratory organs of the slaughtered animals with a solution of cyanide of potassium, the presence of iron in a greater or less degree, and in various degrees as respected the individual portions of the apparatus, was demonstrated in the entire respiratory tract, even in the

* Gazette médicale de Paris, 1861, p. 616.

† Bulletin de l'Académie, September 24th, 1861; Gazette hebdomadaire, September 27th, 1861, p. 627.

parenchymatous tissue of the lungs ; and the blue tinging became still more apparent upon the addition of acetic acid. In order that it might not be objected that the fluid ran down the tracts, the experiment was commenced at the bronchial tubes and continued up into the larynx. In some cases the entire bronchial tree became blue; in others, some portions of the minutest bronchi remained uncolored. The chloride of iron was detected in the cesophagus and in the stomach in consequence of the swallowing of some of the fluid. Immediately after the death of the animals, and at intervals during twenty-four or forty-eight hours, sections of lung were placed in contact with a watery solution of cyanide of potassium, to which acetic acid had been added, which demonstrated the existence of the iron salt in the very cells of the lung.

The animals which had not been killed were attacked with broncho-pneumonia, and some of them with regular circumscribed pneumonia, within a period of from twelve to twenty-four hours ;—a further proof of the penetration of the fluid.

Similar experiments were repeated upon dogs, and with similar results, except that the nebulized fluid was not found in the parenchyma of the lungs.

Upon one of these dogs Demarquay performed the operation of tracheotomy, and then caused it to inhale a solution containing one per cent. of tannin. The wound was tightly closed during the inhalation, which continued several minutes, and at its close he passed into the trachea a piece of paper which had been moistened in a solution of chloride of iron and then dried ; and the inky reaction soon appeared.

In these experiments with the dogs, not only were

their snouts kept forcibly dilated, but their tongues were drawn forwards by means of threads passed through the organ, to prevent any impediment to the entrance of the fluid by contact of the tongue against the soft palate.

Demarquay experimented upon a female nurse in the Hospital Beaujon, who was compelled to wear a canula in her trachea. This is the same case upon whom Fournié experimented with negative results. The laryngeal structures were very much contracted, and the patient could bear the withdrawal of the canula only for a brief period at a time. This female inhaled as best she could a weak solution containing one per cent. of tannin. During the inhalation the tracheal opening was closed by a strip of paper which had been moistened with a solution of the sesquichloride of iron, the paper being confined by adhesive strips, and the whole covered by a napkin. The mouth was placed at a distance of twenty-five centimetres from the distributing tube of a Mathieu's apparatus.

The difficulties in this case were very great from the condition of the glottis, the position of the wound with considerable depression of tissue at that point, and the prominence of the sterno-cleido-mastoid muscles. Twice the experiment failed on account of the yielding of the paper and the adhesive plaster, and their partial detachment from the canula; but, on the third attempt, Demarquay kept his finger applied over the opening, and the strip of paper was withdrawn colored black in considerable extent.

Demarquay lays great stress on the result of this experiment, as being prominently favorable,* for if a

* Gazette hebdomadaire, 1862, p. 391.

larynx so altered from its normal condition, as to be unequal without artificial aid to the admission of sufficient air to sustain life, would permit enough of the fluid to pass it, to be detected by chemical reaction, it is hard to conceive why a larynx in a normal condition would not afford much greater facility of penetration.

At the séance of the Académie de Médecine of Paris, April 29th, 1862, Prof. Troussseau exhibited several sections of the lungs of Demarquay's rabbits in which the penetration of the chloride of iron could be demonstrated even to the minutest ramifications of the bronchi.

Tavernier* experimented on himself with a solution of sesquichloride of iron, and cyanide of potassium. He employed the pulvérisateur of Sales-Girons, and took in long and deep breaths. First, he inhaled the solution of tannin, and then that of the cyanide of potassium; with each he experienced a sensation of cold in the chest, with some feeling of constriction, and a disposition to cough. After the inhalation, an examination with the laryngoscope revealed that the larynx above and below the vocal cords, and the vocal cords themselves to a greater extent, were covered with a sombre layer, which was nothing else than Prussian blue. Then he rinsed out his mouth again and again until the water contained no more trace of the Prussian blue; and after that he endeavored, by hawking and coughing, to bring up some mucus from the trachea or larynx; this, at first strongly though irregularly colored, was afterwards followed by uniformly colored mucus, which, he had not the slightest

* Expériences sur la penetration dans les poumons des poussières liquides tenant en dissolution des réactifs cliniques ou des médicaments.—Gazette médicale de Paris, 1861, p. 808.

doubt, had been brought up from the minute bronchi, in contact with the pulmonary cells.

Prof. Gratiolet, shortly after, repeated Tavernier's experiments upon himself, and reported similar results.*

Bataille took advantage of a chronic inflammation of the mucous membrane of the respiratory organs under which he was laboring, and while endeavoring to cure this, experimented on himself.† He inhaled for a time a solution of the extract of rhatany, and then examined the parts with the laryngoscope. He found the mucous membrane of the larynx and trachea colored red. After a few hours this color had disappeared; nevertheless, during the entire day he expectorated reddish sputa. Bataille concluded that the medicated fluid had penetrated into the bronchi, for his reddish expectorations were of the character designated as "bronchiques."

Moura-Bourouillou‡ experimented on himself, and on patients, with a black fluid. Examination with the laryngoscope discovered the traces of the fluid in the larynx and in the trachea. His experiments upon himself he repeated in the presence of Poggiale. Not only did he demonstrate the presence of the nebulized particles in the trachea, but also their actual entrance and passage through the glottis during inhalation, as observed with the laryngoscope.§

Auphan experimented to discover how far liquids could be made to penetrate into the respiratory tract. With this view he injected into the trachea of a rabbit four drachms of a solution containing one per cent. of

* *Gazette hebdomadaire*, 1861, p. 822.

† *Ib.*, 1862, p. 390.

‡ *Gazette des hôpitaux*, 1861.

§ *La Revue médicale*, December 15th, 1861.

iodide of potassium. No cough was produced. In ten minutes the animal was killed, and he tested the trachea, the bronchi, and the parenchyma of the lungs without producing any reaction with starch. In another experiment he killed the animal immediately after its conclusion, and there ensued a slight reaction. Auphan does not doubt the penetration of fluids into the respiratory tract, which, he thinks, absorbs the material employed very promptly.*

Sales-Girons performed some experiments with an artificial respiratory apparatus which he constructed out of gutta percha, with a mouth, a soft palate raised up, a tongue depressed so as to expose a portion of the posterior wall of a pharynx which was bent at an obtuse angle, and below it, horizontally, at a distance of three centimetres, was a glottis, and a glass tube below the larynx, represented the trachea. When this apparatus was placed before a pulverisateur and inspiration was drawn through the trachea, the liquid penetrated into that tube; but if the tube was bent into an angle the spray was arrested at the first angle, and fell below in drops of water.

REPORT ON THE FOREGOING EXPERIMENTS TO THE PARISIAN ACADEMY OF MEDICINE.

On January 7th, 1862, Poggiale, as chairman of the committee appointed to investigate this question, made an extensive and very interesting report to the *Académie Impérial de Médecine* of Paris, in which he reviewed the whole subject critically, and in which, in answering affirmatively the question, "Do the pulverized liquids penetrate into the respiratory tract?" he based his con-

* *Gazette médicale de Paris*, 1861, p. 315.

clusions chiefly upon the experiments upon rabbits, made by himself and others, principally Demarquay. He even drew positive conclusions from the experiments reported as evincing negative results; showing that in Briau's cases the fluids were clearly proved to have reached the air-passages, although the animals had been allowed to breathe through the nose. He referred to the many causes of error in such experiments, arising sometimes on the part of the experimenter himself, who might lack the necessary chemical, physical, or anatomical knowledge necessary for accurate observation; or from want of intelligence or skill of the assistants; or from the nature of the apparatus employed; or, finally, from the manner of managing the animals, their want of co-operation, their struggles, etc., etc. In alluding to the negative result from Fournié's experiment upon the nurse at Beaujon, he showed how the error in that case must have arisen from imperfect closure of the opening of the trachea during the experiment; inasmuch as Demarquay, in his experiment with the very same individual, had failed twice from such a cause, and did not succeed until the third attempt. Finally, he believed that the experiments of Fournié himself upon the penetration of powdered substances into the air-passages proved the possibility of the entrance of pulverized fluids.

Four months later, in the discussion before the Academy, held April 29th, Durand-Fardel, who had been one of the first to doubt the penetration of these fluids, objected to a portion of Poggiale's views, and for himself came to the following conclusions: that the fluids penetrated to a considerable extent in the subglottic region and in the trachea, but that such penetration as far as the bronchi had not been proved; for everything

went to show that the traces were feebler as the parts were more distant from the glottis; and that, if they did pass beyond the trachea, it was in such small proportion as to deprive them of their therapeutic value.*

The discussion was continued on May 6th,† when Troussseau declared himself warmly in favor of the method, expressing some degree of surprise that a doubt as to the penetration of these liquids could be entertained, since the penetration of coal and other materials was a fact beyond dispute; and, upon an observation being made by an opponent that the larynx is a vigilant sentinel, denying entrance to foreign bodies, Troussseau replied: "It is a vigilant sentinel, perhaps so, but one that can be taken by surprise. When it cries out, 'Who goes there?' it is already too late; in other words, when cough occurs, it is because the liquid has already penetrated into the larynx!" As further proof, he exhibited the lungs of a rabbit which had inhaled but five minutes, and in which not only could the penetration of the solution of the iron salt be demonstrated to have reached the parenchyma of the lungs, but further, to have left traces of the existence of a pneumonia excited by means of this inhaled fluid. "Why," said he, "the fluids may penetrate too much, and it is therefore a method of treatment demanding caution."

Poggiale, in reply to Fournié's objections to his report, replied, that the experiments on men and animals leave no doubt as to the penetration of pulverized substances. The experiments of Fournié prove nothing, if compared with the results of those of Moura-Bourouillou. He

* Bull. de l'Acad. de méd., 1862, vol. xxvii, p. 752.

† Ibid.

did not object to Fournié's results with his various artificial contrivances; but contended that, as we have to deal with men and animals, it is with men and animals that we should experiment, and not with tubes and vessels which have not the elasticity or pliability of organic tissues. In regard to Durand-Fardel's objection that it had not been demonstrated that the liquids penetrated into the bronchial tubes, he brought forward the cases in which its presence had been detected in the lung-tissue; and Demarquay's rabbits, in whom it had produced pulmonary inflammation, for which reasons "the penetration in the bronchial ramifications is an incontestable fact."

Poggiale's report also included the questions as to the change of temperature in the pulverized fluids in issuing from the instrument, the chemical alteration of the sulphuretted waters by the process of nebulization, and the probable value of therapeutical results.

The mineral waters of the various spas do undergo some change, but not so with artificial solutions.

The result of the discussion was an almost unanimous acquiescence with the able report of Poggiale.

FURTHER EXPERIMENTS IN GERMANY, AND ELSEWHERE.

The widely disseminated results of the French experimenters, to which reference has been made in the preceding pages, soon stimulated similar investigation in other portions of the continent, and we have recorded the researches of various observers in Russia, in Germany, and in Spain.

Dr. Friedrich Fieber, of Vienna, was the first to introduce the new method into Germany; and, with the assistance of his brother, Dr. Carl Fieber, he repeated De-

marquay's experiments on rabbits and upon an individual with a tracheal fistule. These experiments were repeated before Prof. Schröff, and confirmed the results of the French observer.

His experiment upon the individual who had undergone tracheotomy differed somewhat from that of Demarquay upon the nurse at the Beaujon Hospital.* This patient was a shoemaker, aged twenty-two years, of strong frame and healthy lungs, who had been received on September 11th, 1861, in the wards of Herrn Primarius Kolisko, and who was under treatment for typhus.

October 3d, he was seized with dyspnea, which, within a few days, increased to such an extent that on the 9th instant he was transferred to the surgical wards, where, on the 11th, the operation of laryngotomy was performed. The patient recovered gradually, but was not able to dispense with the canula.

Some three weeks after the performance of the operation, an attempt was made to withdraw the canula for a few moments, but it had to be promptly returned; and even an experiment made to see how long he could bear a closure of the fistule could not be endured longer than from twenty to thirty seconds.

On the 1st day of January, 1862, Fieber undertook to repeat upon this man the experiment of Demarquay; and the effort was attended with difficulties fully as great as those of his Parisian prototype. In the present instance the difficulty lay less in a contracted glottis, and a strongly projecting sterno-cleido-mastoid, than in the want of intelligence on the part of the patient, who, in addition, was excessively timid, and could not make

* Die Inhalation medicamentöser Flüssigkeiten, etc., p. 44.

up his mind to submit to the inhalation until Fieber had himself inhaled before him. Even then he breathed with so much dread that the first two attempts remained fruitless; but the third attempt, at which he was rather more skilful, gave a positive result, though not to a very satisfactory extent. At the fourth trial, however, the result was more or less similar to that obtained by Demarquay. Fieber employed one of Charrière's apparatus instead of one of Mathieu's, as Demarquay had done, and the solution experimented with contained two per cent. of tannin. He did not place within the opening a piece of paper as a test, but saturated a strip of linen with the solution of the perchloride of iron, and the finger alone was sufficient to close up the opening. Fieber regrets very much that, on account of the many difficulties with which it was attended, he was compelled to forego a laryngoscopic examination at the conclusion of the experiment.

Tobold* exhibited at the meeting of the *Berliner medizinischen Gesellschaft* the lungs of rabbits upon which he had repeated the experiments of Demarquay, and with similar positive results.

Schnitzler and Störk† experimented upon the servant of Dr. Störk, with colored solutions, of rhatany, Campeachy-wood, saffron, etc.; and upon laryngoscopic examination, to which the individual was thoroughly accustomed, the coloring could be detected far down the larynx, and in one instance could be followed into the trachea.

* Deutsche Klinik, 1862, p. 211.

† Wiener Medicinalhalle, 1862, No. 46; Fieber, p. 50; and Wochenblatt der Gesellschaft der Aerzte, 1862, No 45; Lewin, p. 183.

These gentlemen also repeated the often-cited experiment of Demarquay, upon an individual who had undergone tracheotomy some eighteen months previously, on account of the presence of some syphilitic tumors. The method of experiment was that already detailed in connection with Fieber's case. The first two trials failed, but the third, fourth, and fifth succeeded, the patient inhaling more quietly and deeply, and the strength of the solution being increased from one grain to five to the ounce.

The same experiment was then repeated with a dilute solution of iodine, only the linen was not placed immediately in the tracheal opening, but was fastened to a probe and introduced concealed within a thin tube, so that having been pushed forward and brought in contact with the tracheal mucus, it could be removed again concealed within the tube; the fragment then placed in a strong solution of starch assumed the light-blue color. Twice the experiment succeeded; a third time it failed. These gentlemen also repeated Sales-Girons's experiments with an artificial respiratory apparatus, and with confirmatory results.*

Lewin† contributes five experiments; the first two of which were performed in the presence of Prof. Virchow:

1. A middle-sized dog, bound in a towel, was held by one servant, and while another servant held the snout open, the animal was made to breathe the spray of a solution (1 : 100) of the perchloride of iron from a Mathieu Néphogène, great difficulty being encountered in holding the animal so that the spray could be kept directed into his mouth; for he would forcibly turn his head sideways

* Fieber, op. cit., p. 50.

† Op. cit., p. 183.

so as to keep his muzzle out of the line of the current. After the nebulization of twelve ounces of the fluid, the animal, whose eyes had become quite bloodshot in his efforts to free himself, was killed by section of the spinal cord.

The peculiar black reaction with tannin could be distinguished on the soft palate, the posterior pharyngeal wall, the posterior surface of the epiglottis, and at various spots in the trachea, principally on the lateral walls; but not at all in the bronchi or in the parenchyma of the lungs.

2. A more powerful animal was selected this time, and the following device was pursued to manage more easily the head and snout of the animal, and to secure a more favorable position for the experiment: One side of a chest was so cut out that when closed over the neck of the animal it was completely encircled, the head within the box; in the opposite side of the box the delivery tube of the apparatus was admitted through a suitable opening, and through another small aperture Lewin watched the effect. The interior of the chest was soon filled with the nebulized spray, but the dog forced his snout downwards to such a degree that the penetrating particles of the fluid were principally received upon his nose and the upper part of his muzzle, and here condensed without at all entering the mouth. The examination, upon killing the animal directly after the experiment, gave a negative result in the larynx and in the trachea.

3. A powerful rabbit was made to inhale six ounces of a solution of chloride of iron (2:100) at a distance of one foot from the apparatus, the muzzle being forcibly dilated. This animal also was very restless, as were all

the animals with which Lewin experimented. The tongue was allowed to remain quietly in the mouth, and it was observed to lay with its base so much in contact with the posterior wall of the pharynx as to occlude the entrance into the larynx.

On examining the slaughtered animal, the fluid employed was chemically detected upon the upper surface of the epiglottis, on the lateral borders of the lower surface of the epiglottis, and upon the protrusion at its thyroidal attachment; but not in the trachea.

4. The same experiment was repeated with another strong rabbit, the nostrils being compressed and the muzzle held open; and with the same result.

5. The same experiment was performed upon a feeble rabbit, which could be so held that the hands did not compress the abdomen and thus impede the respiratory process, as was the case with the other animals.

In this case the fluid could be detected beyond the bifurcation of the trachea, but not far, and only with slight traces.

In all his examinations upon the cadavers of these animals, Lewin took the precaution to open the bronchi first and proceed towards the larynx, so that no particles of fluid might flow from above downwards during his manipulations.

Lewin, in commenting upon these results, acknowledges that experiments upon animals cannot definitely settle the question of the penetration of these fluids into the respiratory tract. There is a great difference between the voluntary well-directed inhalations of a patient, and the restless, uneasy, unnatural breathing of an animal under experiment, to say nothing of the effect of position of the head, tongue, epiglottis, soft palate, etc.

He also calls attention to the fact that the bronchi absorb readily, and that results may take place during life which cannot be demonstrated after death.

Lewin's views are very similar to those of Durand-Fardel.

PATHOLOGICAL PROOFS OF PENETRATION.

Lewin* details a most instructive pathological case, in which, with Dr. Schulz, chemical assistant to Professor Frerichs, he found free iron in the interior of a cavity in the lung of a patient who, shortly before his death, had inhaled a solution of the sesquichloride of iron. This case is as follows:

"A carriage-driver, Müller by name, æt. 48, whose mother had died with tuberculosis, had suffered from dropsy as early as his seventh year; whether ensuing upon an attack of scarlet fever or not could not be determined. After recovery from this illness, he asserts that he had remained perfectly well until shortly before Christmas, 1861. About this time, during rather a cold spell, he fell asleep upon his box, and on awakening became conscious of a strong drawing pain in the upper thoracic region of the right side. This pain gradually diminished without medical interference, and eventually subsided entirely. Shortly before Easter (April 20th) the patient contracted a fresh cold, attributed to exposure in frosty weather. Since that time he had been expectorating a profusion of sputa, unpleasant to the taste, and producing scraping sensations in the throat.

"After some medicinal treatment, the amount of expectoration became moderated during the daytime, so that only after night, and particularly early in the mornings, the patient expelled the sputa, which retained their unpleasant taste and odor, but with less production of the scraping.

"The patient sought admittance in the *Charité*, and on May 14th his *present condition* was noted down as follows:

"Patient rather strongly built, with moderately developed but rigid muscles. Color of skin normal; enlarged and congested

* Op. cit., p. 190.

bloodvessels to be seen upon the cheeks. Mucous membranes moderately congested. Can assume any position in bed, but feels too weak to remain up.

"*Throat* well proportioned; its muscles slightly employed in costo-abdominal respiration. A swollen lymphatic gland, rather painful upon pressure, upon the scalenus muscle of the right side. The voice somewhat hoarse. No pain in the larynx.

"*Thorax*, in general, well formed, with a slight depression in the region of the seventh rib, right side. The angle of Louis marked, the clavicular furrow deepened, and more so on the right side than on the left. Elevation of thorax tolerably normal, no difference to be detected between the two sides.

"*Percussion* produces a tolerably high, lightly tympanitic sound, at the sixth rib of the right side, in the mammillary line; and so, also, in the right supra-clavicular fossa. Behind, upon both sides, healthy resonance clear beyond the attachment of the twelfth ribs. All over the left side resonance clear, rather higher over the upper lobe than over the lower one. On the right side a tolerably intense dull sound, outwards from the eighth spinous process. Stronger fremitus over the whole of the right side than upon the left side, and especially over the region of dulness.

"*Auscultation*: left and behind, vesicular murmur with some sonorousness and sibilance; over the entire right side very loud moist rattling and scanty râles masking the vesicular murmur. In front, very loud vesicular murmur on the left side, sharp bronchial-like respiration upon the right; expiration rather long; less rattling and whistling than behind.

"The patient did not cough very much during the examination. The cough is much greater at night than during the daytime, and is principally induced by change of position. Expectoration easy, with a small quantity of sputum brought up by each paroxysm of cough. There are no long-continued paroxysms of cough with expulsion of large masses of sputum. The sputum is of a grayish-green color, distinctly translucent, only here and there a few mucous shreds extend from its upper mucous stratum, through a watery middle stratum, to its tolerably homogeneous sediment.

"*The impulse* of the apex of the heart could not be felt; the systolic heaving was diffuse. Cardiac dulness, normal. Sounds clear, the second sound somewhat flapping at the pulmonary orifice.

"The radial artery somewhat serpentine in its course, of rather strong outline, weak beat, and slight tension.

"Tongue with a thick gray covering, especially in its central portion.

"Laryngeal mucous membrane congested, somewhat swollen, and covered with viscid, adherent secretion.

"Abdomen soft and rather flat; a large scrotal hernia on the right side.

"Spleen and liver of normal outline.

"Appetite rather active; thirst frequent. Alvine evacuations at intervals of two days. Urine cloudy, but without containing albumen.

"Temperature 39.5 (C.), pulse 96, respiration 36.

"17th. Morning. Sleeplessness, moderate sweats, severe paroxysm of cough the night previous. Ordered, *Decoct. cinchonæ* (3ij) with *Acid. phosphor.*

"Evening. Temperature 40, pulse 104, respiration 28.

"18th. Morning. Temperature 38.5, pulse 96, respiration 40.

"Patient prefers to retain the semi-recumbent posture, but without fear of dyspnœa. Thorax rather strongly and actively expanded. Expression of countenance quiet. Quantity of expectoration some eight ounces, slimy, grayish-green in color, and covered with froth in profusion.

"19th. Morning. Temperature 38, pulse 96, respiration 44.

"Yesterday evening, after an attack of dyspnœa, coughed up a good deal of blood, which has afforded considerable relief. The sputa during the day, again about eight ounces, of triple consistency as before; only the fluid middle portion is a brownish-red, instead of a grayish-green. Rx. *Plumb. acet.* grs. ij, dose vj.

"20th. Blood coughed up again, but the quantity cannot be determined. Towards noon deep inspiration produces a stitch in the right side, in the region of the right nipple, and extending up to the axillary region. Percussion-sound in the line of the right axilla, appears somewhat shorter than before. Ordered 10 dry cups over the affected region.

"21st. Temperature 38, pulse 128, respiration 44. Has again coughed up blood to the amount of four ounces. The stitch in the side and the dyspnœa have subsided. Ordered *Plumb. acet.* gr. ss., every three hours.

"22d. Temperature 39.4; pulse 120, respiration 44. Again has coughed up about four ounces of blood.

"23d. Temperature 38.5, pulse 136, respiration 60. Profuse sweats, great dyspnœa, intensive cough. Strong hæmoptysis to

the amount of about ten ounces. Treatment: Inhalation from Mathieu's néphogène, of *Liquor ferri sesquichlorati*, at noon and towards evening, each time thirty drops in six ounces of distilled water. Patient rather short-winded, and so weak that it required great effort to make the inhalation; still, he asserted that he felt much more comfortable after the inhalation than he had done before it. He did not cough as much as before by a great deal; the dyspnœa decreased; the amount of expectoration diminished in quantity and less sanguinolent; the patient's countenance fresher and livelier; the speech clearer and stronger than before. Towards evening, temperature 32, pulse 118, respiration 40.

" 24th. Sleepless throughout the night previous, with severer sweat and cough. Expectoration much more difficult. Although respiration appeared performed in great part by the employment of the accessory muscles, there was no feeling of want of breath. The sputum amounted to three ounces, was translucent, the middle stratum dark brown, without any trace of pure blood discoverable in it. Death at 2 P.M.

" *Autopsy*, May 26th.—Marked decrease of subdermoid areolar tissue; the cartilages of the ribs to a considerable extent ossified. On raising up the sternum there was exposed to view, underneath the first rib, a cavity from which flowed out a black fluid with blackish shreds of tissue. Both lungs strongly inflated; the left one totally adherent; the right one less so. From the bronchus of the left lung there gushed forth a muddy-brown fluid; the lung itself large, loose, pervious throughout; only in the posterior portion strongly œdematosus and hyperæmic, moderately strongly pigmented. The bronchi very narrow, even the larger trunks. The muddy liquid distributed pretty fully in the lower lobe. Mucous membrane moderately injected.

" Upon the right side the adhesion was produced principally by thick fibrinous masses, under which the pleura appeared strongly injected. THE LOWER PORTION OF THE UPPER LOBE WAS CONVERTED INTO A SAC, WITH THIN WALLS FIRMLY ADHERENT TO THE THORACIC PARIETES, IN WHICH WAS FOUND THE SHREDS AND THE BLACK FLUID ABOVE MENTIONED, BESIDE SOME BLACKISH-RED LUMPS (BLOOD-CLOTS). The lower lobe rather adherent. Upon its cut surface were seen numerous prominent grayish-white infiltrations; the remaining tissue was void of air, and on pressure allowed the escape of some of the muddy fluid. The middle lobe and the lower portion of the upper lobe showed broncho-pneu-

monic infiltration, surrounded by œdematos tissue. The bronchi moderately large, and mostly filled with a brownish muddy-looking fluid. The vessels of the lungs free from adhesions, their inner walls strongly discolored. In the first rib, between the bone and the cartilage, there was a small space which did not appear to have been made artificially. These extremities of the rib appeared a somewhat muddy-gray, partly cartilaginous and partly striated tissue. Outside of it, communicating with the space, lay a small cavity, which was covered with reddish excrements. The adhesions right at the first rib were rather strong, thick, and, in addition, somewhat slanting.

"In the larynx and in the trachea but little of the muddy fluid. The mucous membrane discolored.

"In the heart much fatty blood. The right cavity rather large in comparison with the left. Valves normal. The pulmonary and aortic valves somewhat glazed. The aorta somewhat dilated above the semilunar valves.

"On the border of the anterior sinus of Valsalva of the semilunar valve of the pulmonary artery, and towards the left, was discovered a small opening leading to a blood vessel, which formed a small sac on the outer side of the aorta, and from which several branches coursed over the aorta; one of the largest of these communicated, by a free vessel at the base of the left ventricle, with a small artery which arose, with a calibre of about a line, from the aorta, close to the posterior coronary artery. Close to the opening of the posterior coronary artery there was a still smaller aperture, from out of which air could be forced by blowing into the network of vessels described as originating from the pulmonary artery. At the commencement of the aorta there were a great many adhesions, chiefly rounded superficially.

"THE BLACK-COLORED LIQUID FOUND IN THE PROTECTED CAVITY IN THE LOWER PORTION OF THE UPPER LOBE WAS EXAMINED BY THE CHEMICAL ASSISTANT, DR. SCHULZ, IMMEDIATELY AFTER THE AUTOPSY, AND SHOWED THE PRESENCE OF FREE IRON, AS ALSO DID THE BLACKISH CLOTS—OF COURSE BUT IN SMALL PROPORTION. Here we have the strongest possible evidence of the penetration into the lung of inhaled nebulized fluids."

In a somewhat similar case related by Prof. Zdekaucr,

of St. Petersburg,* a patient died from debility shortly after the restraint of a profuse haemoptysis by inhalations of a strong solution of the chloride of iron. Everywhere in the tissue of the lung Dr. Holm discovered iron in greater quantity than could have been due to the blood. As Fieber mentions in a footnote, this case proves the penetration of the fluid into the minutest ramification of the bronchi.

Waldenberg† instituted a great number of ingenious experiments upon men and animals, not so much to prove the entrance of the material into the respiratory tract, of which ability he had no doubt, as to determine the quantity or proportion that thus penetrated, and also in what form they reached the parts, whether still as spray or condensed into drops; but, for reasons that are obvious, he was unable to come to any satisfactory conclusion.

Prof. Gerhardt,‡ of Jena, repeated a number of experiments upon men. He caused several invalids to inhale a chloride of iron solution, and shortly after, by the aid of the laryngoscope, he pencilled the larynx with a solution of tannin. The laryngeal image showed the inky reaction on the apices of the arytenoid cartilages, and on the posterior surface of the epiglottis; in one case, several dark spots could be seen upon the true vocal cords. In one patient, with a fistule between the hyoid bone and the thyroid cartilage, a paper which had been dipped into a solution of tannin was held in the fistule

* Wiener méd. Woehenschrift, No. 30, 1861; Fieber, op. cit., p. 42; and Lewin, op. cit., p. 240; et al.

† Op. cit., 1st edition, pp. 111-165.

‡ Inhalation medikamentöser Flüssigkeiten. Ein Beitrag zur Localtherapie respiratorischer Erkrankungen. Von Rudolf Wedemann, Jena, 1862; quoted by Fieber, op. cit., p. 49.

after a few inhalations of a solution of the chloride of iron had been taken, and the usual reaction of these salts ensued.

Wedemann* records many clinical observations confirmative of the question discussed.

Semeleider† found that after the inhalation of astringent solutions, the secretions collected at several places in the larynx as whitish floccules, with a reduction of the capillary injection attendant on inflammation of the true and false vocal cords.

Prof. Niemeyer‡ states that the fact of the entrance of these sprays admits of no doubt. He had treated with markedly satisfactory results, chronic laryngeal catarrh, follicular laryngitis, and pharyngitis, etc., employing solutions of alum, tannin, and nitrate of silver.

Dr. Morell Mackenzie,§ of London, stated at a meeting of the Royal Medical and Chirurgical Society of London, February 14th, 1865, that, in conjunction with Dr. Duchesne, of Woodford, he had performed some experiments upon pigs and dogs, and with positive results; and Dr. Gibb expressed his conviction, based upon his own observations, that the fluids penetrated into the minutest bronchi.

Besides the experiments above detailed, many others were instituted by different observers in various parts of Germany, in Russia, Spain, Great Britain, and elsewhere; but the results do not differ from those already recorded. The entrance of the nebula, upon voluntary inspiration,

* Op. cit., pp. 30-43.

† *Wochenblatt der Zeitsehrift d. k. k. Gesellsch. der Aertzte in Wien*, 1864, No. 1, quoted by Fieber, op. cit., p. 51.

‡ *Manual of Speial Pathology and Therapeutics*, 6th edition, 1865.

§ *Med. Times and Gazette*, 1865, No. 765, p. 213.

into the larynx, can easily be demonstrated by causing an individual to inhale a colored solution, as of indigo, anilin, or the like, under circumstances favorable for penetration, and then examining the parts by aid of the laryngoscope.

In these experiments it is desirable to secure as finely divided a nebula as possible, and its delicacy can be tested by using a colored solution, as of indigo, and allowing the spray to strike against a piece of unglazed paper, which will become more or less completely covered, showing the degree of tenuity of the drops; a plan first employed by Siegle, who binds up in his work a page on which is pasted two strips of paper thus subjected to two apparatuses, his own having produced a spray so fine that the paper looks as if it had been dipped in the solution, so evenly is it colored. Another method of testing the degree of subdivision, and which is applicable to any solution, is to allow the nebula, as it is produced, to strike against a pane of window glass, and notice the minuteness of the condensing particles.

Thus, in despite of the experiments with negative results, we are led to the conclusion that nebulized fluids can be inhaled deeply into the respiratory tract; and that when failure occurs it is due to unfavorable position of the epiglottis, or an improper method of inhalation.

THE INHALATION OF NEBULIZED FLUIDS.

From what has already preceded, it is evident that the inhalation of nebulized fluids can be utilized in the alleviation and cure of disease; and that the method

greatly enlarges our store of resources in local treatment. It presents us with a means of affecting the system by absorption, without compromising the digestive powers of the alimentary canal, or interfering with them; for the mucous membrane of the air-passages is much quicker to absorb than that of the stomach. Then, too, the attenuated form in which the remedy is presented secures a subdivision of labor, as it were, on the part of the absorbent vessels, so that an effect more prompt and sustained may be produced, than when the remedy is presented in bulk and thus subjected to gradual ingestion. Finally, the absence of a digestive process secures the absorption of the remedy in the chemical form in which it is exhibited.

It will be seen in the sequel, that the powers of absorption of the pulmonic mucous membrane have been utilized for systemic medication in instances where idiosyncrasy or disease has prevented the administration of remedies by the usual avenue.

THE PROPORTION OF NEBULA INHALED.

It is difficult to estimate the proportion of nebula which reaches the larynx, trachea, and lungs. Experiments have been made by several observers to determine this point, but their results are only approximative.

The following results were obtained by Beigel* with Siegle's apparatus:

"If the boiler, which contains about eight ounces, is half filled, viz., with four ounces of water, and the lamp beneath lighted, the evolution of steam begins in about ten minutes. One ounce of

* Op. cit., pp. 49-51.

fluid is then, between twenty-five to thirty minutes, turned into spray and inhaled. The quantity of condensed fluid, after the inhalation obtained through the tube of my screen, is about four drachms, the loss in the boiler one ounce. Half an ounce of medicated spray was, therefore, mixed with one ounce of steam. About half of that quantity recoils from the screen into the air, while the other half reaches the mouth. Here, again, about half the quantity remains, to be either swallowed or spit away, whilst *the other half, viz., about three drachms of mixture of steam and medicated fluid passes the glottis and penetrates into the respiratory tract.* In respect to that mixture, the conclusion may fairly be drawn that it contains a far greater quantity of atomized fluid than vapor. Not only because it can be assumed, *a priori*, that the heavier particles of the fluid are driven by the force of the blast into the mouth, whilst the lighter steam mixes very readily with the atmosphere, but because an analysis of the fluid, obtained by condensation, shows that the original strength of the solution is diminished but little; at least, it was so in solutions of common salt, which I have tested. The experiment, to show that the steam dissolves into the air, while the atomized clouds rush forth, can easily be made with my screen. The opening through which the patient inhales is closed, the apparatus put into action, and the condensed fluid gathered. If steam merely escapes, we find that after one ounce of water has been turned into steam, about twenty minimis only have been condensed and gathered in the vessel, while it contains about six drachms, when atomization has taken place at the same time. *The conclusion is, therefore, obvious, that the strength of the medicated fluid is altered but very little through its mixture with the steam."*

The probabilities are, that from one-twelfth to one-sixth of the fluid nebulized reaches the respiratory tract; but we must allow for the absorption by the buccal mucous membranes of much that reaches the mouth and is there condensed; and as the proportion differs much according to the manner of inhaling, the doses to be employed will vary according to the proportion apparently actually inhaled in any given case; in determining which, the physician will have to depend upon his

own judgment after witnessing his patient's manner of inhaling.

Dr. James Collins, of Philadelphia, has furnished me with the following result of some experiments instituted by him, in 1866, to ascertain the probable amount of nebula received into the system.

A steam apparatus was used with the Bergson tubes. The amount of drippings collected were carefully evaporated, and the residue weighed:

Ferro-ferricyanide of potassium, grammes 2,

were dissolved in 2 ounces of water.

Residue from drippings,	grammes	1.445
Loss, . . . . .		.555
<i>Sulphate of copper</i> ,	grammes	2
Residue in drippings,		1.181
Loss, . . . . .		.819
<i>Bicarbonate of potassa</i> ,	grammes	2
Residue from drippings,		1.545
Loss, . . . . .		.455
<i>Nitrate of potassa</i> ,	grammes	2
Residue from drippings,		1.285
Loss, . . . . .		.715
<i>Muriate of ammonia</i> ,	grammes	2
Residue in drippings,		1.845
Loss, . . . . .		.155

An analysis of the residue of fluid, containing chlorate of potassa 20 grains to the ounce, and deposited on the

sides of a mouth speculum which had been used in inhaling, resulted as follows :

On speculum,	.	.	.	.	.	grammes	.058
Residue of 4 ounces of fluid,	.	.	.	.	.		2.755
						<hr/>	<hr/>
Total residue,	.	.	.	.	.		2.813
						<hr/>	<hr/>
Original contents, 80 grains,	.	.	.	.	.	grammes	5.183
						<hr/>	<hr/>
Loss,	.	.	.	.	.	.	2.370
						<hr/>	<hr/>

IMMEDIATE EFFECTS OF THE INHALATION OF NEBULIZED FLUIDS.

If the nebula passes beyond the glottis, a peculiar sensation is immediately felt in the trachea and upper sternal part of the chest, according to the depth of the inhalation and the amount of permeation by the fluid. As facility of inhalation is acquired, this sensation will become diffused over a greater extent of surface. If the fluid nebulized be at the ordinary temperature, a sense of cold will be felt in the parts ; and if ice-water be inhaled the sense of cold will be very distinct. Sometimes a sense of oppression, and occasionally of real soreness, is experienced, especially when, at a first attempt at inhalation, a strong solution as of an astringent or caustic is employed ; hence it will sometimes be found desirable to let a patient inhale some bland fluid at his first attempt until he becomes accustomed to the method, unless it be a case of haemoptysis, when it is better to proceed at once with the astringent. Haemoptysis has occasionally been induced by inhalation, having, as will be seen in the following pages, occurred under the observation of Fieber. I have witnessed the same result. Dr. Da Costa* has seen from the inhalation of a strong

* Essay on Inhalation, N. Y., 1866, p 20.

solution of alum, asthmatic wheezing breathing very speedily produced, with loud, dry râles discernible at various parts of the chest; the attack lasting from eight to ten minutes. Dr. Collins* has witnessed the same effect.

If discomfort arise during an inhalation, the process should be suspended, and the parts gradually accustomed to the procedure; and if the effect should follow invariably, the method should be discontinued.

Usually, the sensation is not disagreeable; the first few inhalations induce titillation of the glottis, provocative of cough; but this soon ceases, and cough is not produced at subsequent inhalations; and, indeed, in some instances, the inhalation does not produce any cough. As a general rule, there is cough at the conclusion of each inhalation, or shortly after it, attended with greater freedom and increased facility of expectoration.

If there is inflammation of the upper air-passages with pain and soreness, the inhalation almost invariably affords an immediate feeling of relief; probably by supplying moisture to the parts, and of course as a topical effect also of the narcotic or sedative which may be employed.

MANNER OF CONDUCTING THE INHALATION OF NEBULIZED FLUIDS.

The patient should sit at ease in front of the apparatus, the distributing-tube from which should be on a level with his mouth. Siegle recommends that the patient lean the chest forward with the elbows or arms resting upon the edge of a table. I have found this position in general the most suitable and convenient, except in irregular cases. Waldenburg recommends that the

* Verbal communication.

patients should, when strong enough, stand up and take their inhalations ; but this position does not permit of as free an expansion of the chest, and calls off part of the muscular force of the auxiliary muscles of respiration for the maintenance of the erect posture, and, necessitating frequent respiration, the inspirations are, of course, less deep. Lewin prefers that the back should be supported, instead of permitting the patients to lean forward.

As soon as the apparatus is in action, which, with the steam apparatus, will usually be in from three to five minutes after the application of the flame,—and sooner, if the precaution be taken to introduce hot water into the boiler, thereby saving time and alcohol,—the patient should be directed to incline his head a little backwards, thus bringing the oral and laryngeal cavities more towards a direct line. The spray, with or without the intervention of a funnel or face protector, is then allowed to pass into the mouth of the patient, who should make deep and rhythmic inspirations and expirations.

It is impossible to give precise rules as to the distance from the apparatus at which the patient's mouth should be maintained, or the time that shall be occupied in each inhalation. Differences suitable to each case, dependent on irritability of structures, aptness at inhalation, etc., will occur with every individual. Usually a rather warm spray is more pleasantly endured at a first inhalation ; and therefore it is well at the beginning of each inhalation to place the delivery-tube at a distance of but from four to six inches from the mouth of the patient, and then gradually increase the distance to from twelve to twenty-four or more inches, as may be most suitable. If the laryngeal structures are very irritable, the first sitting should not occupy more than five minutes, and

the inhalation should not be repeated on the same day. As the parts become accustomed to the irritation, and the facility of inhalation increases, the period of each inhalation may be increased to ten or fifteen minutes, and it may be repeated from two to ten times a day, according to the indications.

It will be found a better plan to designate a certain quantity to be inhaled as a dose, and gradually increase it, than to prescribe a certain number of inhalatory efforts, or a certain duration of time; as regard to either of these particulars distracts the attention of the patient.

The temperature of the spray lessens with the increase of its distance from the apparatus. The force of the current is also diminished in like manner, but in a less degree; this depending rather upon the rapidity with which the steam is formed, and the heat regulated, by altering the size of the flame.

The following are the rules laid down by Siegle to be observed with his apparatus, provided with a thermo-barometer to indicate the steam pressure:

1. { Stream strong. Temperature high.
Thermo-barometer 2°.* Distance 2-6 inches.
e. g., In Croupous Laryngitis.
2. { Stream strong. Temperature low.
Thermo-barometer 2°. Distance 1-2 feet.
e. g., In Chronic Pharyngitis.
3. { Stream weak. Temperature high.
Thermo-barometer 1°. Distance 2-6 inches.
e. g., In Tuberculosis of Lungs and Larynx.
4. { Stream weak. Temperature low.
Thermo-barometer, 1°. Distance 1-2 feet.
e. g., In Hæmoptysis.

* Indicating a pressure equal to two atmospheres.

In the apparatus of Sales-Girons and others, working by pressure, the temperature can be elevated by means of a flame placed behind the drum ; the current of the nebula creates a vacuum directly behind the point on which the spray strikes, and this draws the flame inwards and heats the spray.

It is difficult to lay down special rules which shall be applicable to every case ; and hardly necessary, inasmuch as every physician employing this method soon learns by practice to regulate the manner of inhalation so as to suit his cases. Practice soon enables a patient to inhale properly, and also to overcome the disposition to cough, which is sometimes very great at the commencement. Where difficulty is anticipated, or where patients manifest considerable concern, it will be best at first that they should merely be allowed to inhale the steam that issues from the apparatus ; or simply the spray of plain water, to which the medicated fluid can then be added gradually. For the same reason the pressure of the steam at the commencement of a sitting may be moderated, gradually rising to a higher degree of the thermo-barometer by enlarging the size of the flame.

With patients who are more intelligent, but at the same time nervous, a somewhat similar management may become necessary. Such patients can sit at first a little sideways, so that the current streams by the side of the face ; then, as they become accustomed to it, they can bend forward from time to time so as to get the open mouth in the passing current, and then take in a deep breath of the spray from the side.

With small children and bed-ridden patients, the apparatus can very readily be so placed that the current can be directed into the mouth of the patient while lying

upon his side. The pillows and adjacent bed coverings must be covered with some suitable material, in order to protect the bed from moisture.

Larger children are most conveniently managed by taking them upon the lap in order to remove their anxiety, and showing them the movements of inhalation. In this manner children of three years of age soon learn to inhale with real enjoyment or childish delight in the process.

Moura-Bourrouillou recommends holding the nostrils closed by means of the finger or some speial contrivance, in order the better to secure penetration of the spray into the air-passages. This is useful in occasional instances, where a patient will not breathe through the open mouth, and persists in performing the respiratory act through the nostrils. Traube recommends that the patient should extend the tongue well out of the mouth; and my own experience is eonfirmative of the usefulness of this position of the tongue, in cases in which penetration of the nebula is required as far as the trachea, or still farther down the respiratory tract. Siegle holds both of these directions unnecessary; and quite the reverse, if the tongue is very fleshy, and seems to be much in the way, lessening the oral orifice, he directs the patient to keep it depressed himself with a knee-shaped spatula. The mouth speeulum subserves the purpose of a tongue-depressor.

The physician must by no means neglect to watch the first inhalations of his patient; otherwise, after a few moments, the tongue will be allowed to bulge up so that its base will press back upon the soft palate instead of being flatly applied to the floor of the mouth, with the tip behind the lower incisor teeth; or the head will have

assumed an unfavorable position, the mouth be no longer properly opened, the inspirations become less energetic, or too frequent, etc., etc.

Siegle also recommends that, in the beginning, the patient take an inspiration as if he were going to gape, or inspire after a quiet prolonged articulation of the diphthong sound *œ*.

At the close of the inhalation, the patient should cleanse the mouth and pharynx by gargling with fresh water. If, however, the inhalation has been taken for an affection of the mouth or pharynx, this gargling can be dispensed with, that the medication may secure a longer local effect.

In concluding, Siegle cannot call too much the attention of physician and patient to the following rules:

1st. Take care that the temperature of the spray and the strength of its propulsion remain constant during the entire continuance of the sitting. This has reference to the patient's distance from the instrument, as well as the pressure as indicated by the thermobarometer.

2d. Never permit an inhalation to be taken after bodily exercise or mental excitement, so long as the temperature of the skin remains elevated, or the pulse or respiration disturbed.

3d. Several hours must elapse between a hearty meal and the inhalation.

4th. In affections of the pharynx the respiratory efforts of the patient need not exceed those of his ordinary breathing. In affections of the larynx, the windpipe, the bronchi, and the lungs, the force of the inspiration must be greater in proportion to the distance of the affected structures from the mouth; the deepest inspirations being necessary in affections of the lungs.

5th. Let the patient rest awhile from time to time during the inhalation; and under no circumstances must the length of a sitting exceed a period not justified by the strength of the patient.

6th. The excess of spray condensing in the mouth and accumulating, especially when not composed of harmless substances, such

as mere water, common salt, etc., must be expectorated into some conveniently placed receptacle.

7th. Children and infants should not be out of view for a single moment during the inhalation.

8th. After the inhalation let the patient, who will then begin to cough more than usual, remain quiet for a quarter of an hour before he leaves the apartment.

9th. During the inhalation the patient should not be allowed to speak, nor should any conversation be held with him. His entire attention should be directed upon the inhalation.

Before proceeding with a medicinal solution it is often well, especially with nervous patients, to begin with pure water, and gradually add the medicated solution drop by drop. In some cases, where even water could not be inhaled, Beigel has found advantage from employing milk, after the inhalation of which for some time, he has been able to proceed with the desired remedy.

With some children Hauk succeeded by forming his solution into an emulsion, so that it was mistaken for milk, and thus inhaled more readily than if the subterfuge had not been resorted to.

NUMBER, STRENGTH, AND DURATION OF INHALATIONS, ETC.

The time which shall be devoted to taking an inhalation will depend upon the quantity of the medicament which is desired to be introduced at each sitting, and upon the special apparatus employed, the minuteness of the particles of the spray, and considerations of a similar character. The glass apparatus of Lewin has been so constructed as to nebulize two ounces of fluid in one minute by from forty-eight to fifty-two strokes of the pump; and as he has found the most convenient quan-

tity for each inhalation to be forty-eight ounces, it will require twenty-four minutes to reduce this amount into spray. This will be found rather a tiresome sitting for most patients, and also very wasteful of the fluid, for Lewin's own experiments show that of the forty-eight ounces nebulized, but three ounces find entrance into the mouth of the patient; and therefore the strength of the solution must be so graduated as to contain in three ounces as much of the substance dissolved as is desired to be brought in contact with the mucous membrane of the pharynx, larynx, bronchi, etc.

With the apparatus of Bergson, eight ounces are required to be nebulized to introduce three ounces of spray into the mouth, which will occupy from twelve to fourteen minutes, and require about forty-eight compressions of the bellows or bag. With Mathieu's néphogène six ounces are required, consuming from ten to twelve minutes. With Lewin's steam hydrokomion, four ounces, and twenty minutes. It is difficult to say how much of this spray goes beyond the larynx or into it. With most of the steam apparatuses it takes from ten to fifteen minutes to nebulize an ounce—the usual amount employed for one inhalation; but by increasing the force of the steam, and enlarging the size of the capillary openings of the tube, the same result can be accomplished in from four to seven minutes.

For acute diseases, usually three and four inhalations daily will be sufficient. More frequent inhalation will be requisite in croup and diphtheria. In chronic affections one or two a day will suffice, and these may occupy from ten to thirty minutes each.

When an inhalation is intended merely to reach the pharynx or upper portion of the larynx, the patient may

sit so that his mouth is within a few inches of the spray as it is produced, at which distance the force of the spray is too strong to be carried far out of a straight line by mere ordinary inspiratory effort ; but if it is to reach the smaller bronchial tubes, he should be placed at a distance of about two feet, or even more with a good apparatus, in order that the molecules of spray, their own force of propulsion being exhausted so that they are merely suspended lightly in the atmosphere, may be carried in the inspiratory current to the deeper structures.

ARTICLES OF THE MATERIA MEDICA SUITABLE FOR NEBULIZATION.

Any article of the *materia medica* soluble in water or in weak alcohol, is suitable for submission to the process of nebulization. Distilled water, rain water, and river or spring water that has been boiled, are the best vehicles for the solution. Hard water, by the substances held in solution, is apt, at times, to irritate a delicate respiratory mucous membrane. Oils, and solutions in glycerin, are also sometimes employed. A fine spray cannot be produced with them, inasmuch as the aperture from which the fluid escapes must be larger than for aqueous and spirituous solutions ; still, for applications anterior to the larynx they are much better adapted than ordinary pencillings or garglings, because, by the minute subdivision of particles, more complete contact is secured, as well as a more continuous effect.

The natural sulphurous waters are decomposed by this process, giving off their hydrosulphurous acid ; but the extemporaneous solutions usually employed are not thus altered.

The materials used should be chemically pure; and the solutions should be well filtered before using, in order that no sediment may accumulate to clog up the aperture through which the fine stream of fluid is forced.

Simple pharmacy is more necessary to be observed here than in the administration of remedies by the stomach; and it is best always to begin with as weak a solution as will suit the case, the substance employed to be selected with reference to its physiological and therapeutic influence upon the constitution, as well as for its topical effect.

The absorptive power of the mucous membrane of the respiratory organs being much greater than that of the stomach, poisonous substances must be employed with great caution, and their doses be augmented very gradually.

The strength of any solution to be employed will vary with the individuality of the patient, his distance from the instrument, the length of the sitting, and similar considerations.

The list in the sequel comprises most of the remedies used for purposes of inhalation by the process of nebulization; with the doses in which they are usually employed, the diseases for which they are recommended, and, as far as could be ascertained, the authorities by whom they were first recommended. The nomenclature is, in the main, that employed in the latest (1873) edition of the *Pharmacopœia of the United States*.

Sales-Girons considers inhalations in the form of spray indicated in acute and chronic diseases of the pharynx, larynx, trachea, bronchi, and lungs; in nasal catarrh, in asthma, in tuberculosi s; also in acute ton-

sillitis, pharyngitis, bronchitis, pneumonia, simple and pseudo-membranous sore throat, diphtheria, and croup. At first he employed the method in chronic affections only, and the earlier remedies resorted to were the sulphurous waters of Eaux-Bonnes, Pierrefonds, de Labassière, etc.; and inasmuch as the treatment was instituted at these various watering-places, the plan pursued was that the patients should drink one glass of the mineral water every morning upon the empty stomach, and afterwards inhale a certain quantity broken up into spray by the pulverisateur.

Subsequently he increased his *materia medica* by the addition of tar-water, salt and water, and solutions containing iodine and chlorine; and finally he added the emollients, sedatives, and antiseptics, the chloride of iron in cases of haemoptysis, and quinine as an antiseptic in the last stages of tuberculosis. The duration of the inhalation depended on the condition of the patient, the stage of the disease, and the nature of the remedy. In chronic affections of the respiratory organs, where sulphurous waters, tar-water, and emollient remedies were employed, the sitting continued some twenty minutes,—the time ordinarily consumed in nebulizing a glass of the mineral water. The inhalations were given twice a day, the first one in the morning before meals, and the second towards evening. When deemed advisable, and well borne by the patient, a third inhalation was permitted in the afternoon.

In presenting the following arrangement of remedies, no attempt has been made at systematic classification. Indeed, it would be difficult to adopt a classification which would be satisfactory, physiologically or therapeutically, without having to go over much of the

ground more than once, thus incumbering the volume unnecessarily. It is believed that the index will be found sufficient for the ordinary purposes of reference; and therefore, although a certain amount of order has been maintained in the succession of some of the topics, all the applications of any one remedial agent have been included under the same heading.

WATER.

Cold water is employed, according to indications, as a detergent, astringent, antiphlogistic, or styptic. It is a very grateful application in many inflammatory affections of the throat, especially in tonsillitis; allaying heat, supplying moisture, and cleansing the parts from secretion. Some patients prefer iced-water, but water below 60° is often cool enough to be agreeable. Prof. Zeitz* reported the best results in angina tonsillaris from nebulized iced-water; and his observations have been abundantly confirmed. Waldenburg believes that he has cut short many a commencing angina, in subjects predisposed to it, by adding ice to the medicated fluid he has employed.

In haemoptysis, the inhalation of the spray of cold water or iced-water will sometimes serve to restrain the haemorrhage. It was first recommended for this purpose by Fieber,† who states that where it can be borne, the inhalation of the spray of cold water (8°–10° R.) suffices in slight cases of haemoptysis, and in cases of bloody sputa. Other remedies, however, are more frequently resorted to in this condition.

Warm water is of very frequent and varied service in

* Fieber; op. cit., p. 106.

† Allg. Wien med. Zeit., 1862, No. 16.

the topical treatment of affections of the throat and respiratory organs. It can be employed as an emollient, detergent, expectorant, absorbent, stimulant, and sedative, according to the temperature of the spray and prolongation of the inhalation. This spray affords one of the very best means of promoting secretion, of diluting viscid mucus or pus or other excretion, and of facilitating the detachment of these products from the mucous membrane of the air-passages. It is an immediately grateful application, as well as more remotely remedial in almost all forms of inflammation of the pharyngeal, laryngeal, and respiratory mucous membrane. It cleanses the parts from secretion, soothes their inflamed surfaces, and relieves pain. It is probably the main beneficial agent in most inhalations, no matter what the medicinal remedy it holds in solution.

It has been found useful in coryza, acute or chronic. I have never tried simple warm water in these complaints, because I have preferred saline solutions; but it is easily understood how it will cleanse the surfaces and keep them in a healthier condition.

In mild cases of simple sore throat, inhalations of lukewarm water will often suffice as far as topical treatment is concerned; and they are often equally efficient in most other acute superficial inflammations of the pharynx and larynx.

In acute catarrhal bronchitis, nebulized warm water often affords considerable relief, and increases the facility of expectoration. In chronic bronchitis, also, simple inhalations of warm or tepid water, and sometimes, indeed, even of cold water, employed several times a day, for from ten to fifteen minutes at a time, will often, as I have abundantly proven in my own practice, yield re-

sults that are very gratifying. The bronchial tubes are kept cleansed of mucus, expectoration is facilitated, and a gentle recuperative influence is exercised upon the mucous membrane. If desired, the water may be just impregnated, as it were, with benzoin, cologne, or toilet vinegar, to render the inhalation more agreeable, or to occupy the patient's mind with the semblance of a potent remedy.

In the dry variety of the affection, bronchitis sicca, the inhalation of warm water spray is prominently indicated, and it will often be found to subserve a useful purpose by supplying the moisture so much needed.

In the bronchitis of pulmonary phthisis, likewise, the inhalation of warm water spray will facilitate expectoration and afford relief; and it is frequently resorted to for this purpose in my own treatment of these affections.

Siegle relates* a case of rheumatic aphonia in a student, in which the voice improved, day by day, under several inhalations daily of hot vapor of water, so as to leave nothing more to be desired on the eighth day.

Inhalations of the spray of hot water have been found beneficial in the treatment of croup and diphtheria, as an agent in facilitating the expulsion of false membrane. I have not used the warm water spray, preferring to employ the copious evolution of the hot vapor of water, as expressed in a previous portion of this volume.

Siegle† reports a very severe case of membranous croup with impending death, in a child two years of age, for whom he had tried all the usual remedies in vain.

He was about instituting inhalations of nitrate of silver or

* Op. cit., p. 71.

† Op. cit., p. 60.

tannin, when the rapidly threatening symptoms of want of air seemed to him to be less due to obstruction by croupal membrane, than to ineffectual attempts to detach the accumulating mucus; to assist these, he administered inhalations of warm steam, and very soon the patient began to spit out portions of the membrane. After an inhalation of a quarter of an hour, the child breathed more freely, and after twenty-four hours,—during which the inhalation was more or less kept up day and night, the child bringing up a good deal of mucus and shreds of croup membrane, which the mother removed from its mouth with her finger,—the life of the little patient was saved.

Dr. Wittmeyer, of Nordhausen,* proposed the inhalation of nebulized water in the asphyxiative stage of cholera, in order to convey water promptly to the thickened blood, and thus render it more diluent, and capable of circulating more freely.

In a memoir presented by Sales-Girons to the Parisian Academy of Medicine,† on respiratory therapeutics, and upon which M. Béclard has made a report, it is claimed that these inhalations may be safely resorted to in a great variety of diseases, for the purpose of producing constitutional effects, because the mucous membrane of the respiratory organs exceeds all other mucous membranes, including that of the small intestines as well as the stomach, in its powers of absorption, as a consequence of the rapid passage of the entire mass of the blood through the lungs, exposing, within the space of less than half a minute, almost every globule of that fluid to the action of any remedy, through the endosmotic action of an extremely attenuated membrane of great absorptive power. In proof of this capability of absorption, it is stated that twenty-five litres of water

* Deutsche Klinik, Oct. 13th, 1866.

† Gaz. hebd., No. 10, 1867.

may be injected into the bronchi of a horse within six hours, and become at once absorbed without occasioning any sensible injury to the animal.

There may, therefore, be good grounds for Dr. Wittmeyer's idea of conveying water to the blood promptly in states of asphyxia, by means of its inhalation in the form of nebula.

MINERAL WATERS.

Natural mineral waters were the medicinal agents first employed in the form of nebula or spray. This appears to have been simply due to the circumstance that the method of treatment originated at "the springs." Beginning with the sulphurous waters, the alkaline and saline waters were soon brought into requisition for the fulfilment of various indications.

Sulphurous Waters.—Some of these waters are warm and others are temperate. It is known that much of the sulphurous acid in these waters is lost in the very process of nebulization; still, however, a sufficient impregnation remains to exert a gentle tonic influence upon the parts, if no more. In France, the waters of Pierrefonds, Eaux-Bonnes, and Euzet-les-Bains, were those first employed; then those of Sehinznaeh, in Switzerland, Wistinghausen, Baden near Vienna, Aachen, and so on. I do not know that the natural sulphurous waters in the United States have ever been administered in this way.

These sulphurous waters have been recommended by Sales-Girons, in the hoarseness of chronic laryngitis and bronchitis, tonsillitis, so-called granular pharyngitis, follicular inflammation of the larynx and pharynx, aphonia, spasm of the larynx, bronchial catarrhs, asthma, and

pulmonary phthisis. Auphan recommended the waters of Euzet-les-Bains in pneumonic hepatization of recent or of non-recent standing; although, at the same time, he considered the inhalations contraindicated in cases with existing inflammatory fever.*

Spengler has expressed the belief that these mineral waters restore the functions of the ciliary epithelium.

They have also been recommended by the French physicians, in affections of the heart.

Alkaline Waters.—These waters were first recommended by Auphan, in laryngitis and pharyngitis, with viscid secretion and troublesome expectoration; and also in the first stage of phthisis. The waters of Ems and Viehy, and so on, have been employed in the same affections by Wistinghausen and others; and the Ems water is said to be particularly useful in catarrhal inflammations with scanty secretions. The principal medicinal ingredients of this water are bicarbonate of sodium and chloride of sodium in minute proportions.

Saline Waters.—The strongly saline waters are also much used for inhalation, largely diluted with simple water. Of these we may mention the waters of Kissingen, Baden-Baden, Reichenall, Isehl, and so on. They have been used with more or less success in chronic superficial, non-specific, inflammatory affections of the respiratory passages generally.

I have no personal experience with the use of mineral waters by nebulization, except in a few instances in which they were of no greater use than extemporaneous solutions of their chief ingredients in similar proportions.

* Siegle, op. cit., p. 85.

CARBONIC ACID WATER.

The ordinary carbonic acid water of the shops, so much used as a summer beverage, forms an agreeable refrigerant and slightly stimulating inhalation in many cases of sore throat in general. I have had quite satisfactory results from its frequent employment in cases produced by misuse or overuse of the voice, especially of those who use the voice loudly in the open street or in large and crowded apartments.

GLYCERIN.

Dose.—A few drachms to an ounce, undiluted, or diluted with from one to ten parts of water.

This remedy is often employed as an emollient to relieve irritation in inflammatory affections of the larynx, trachea, and bronchi, of whatever nature. It is likewise used in the oedematous conditions of the larynx ensuing in the course of the chronic laryngitis of phthisis and of syphilis; often with the view of promoting exosmosis of the effused fluid, a theoretic result which practice has not often confirmed under my own not infrequent experiments to this end. It is often employed with water as the menstruum for other remedies. Thus Demarquay has recommended one part of tannin with fifty parts of glycerin, and one hundred parts of water, to soothe irritation from inflammation of the pharynx, particularly if employed in the early stages. It is recommended by Dr. Scott Alison in laryngitis and tracheitis associated with hoarseness and loss of voice; by Stehberger in laryngitis, with inveterate hoarseness and impairment of voice; by Fieber in whooping-cough; and by Leiblinger in the dry cough of phthisis. Steh-

berger has recommended glycerin highly in croup,* employed undiluted or slightly diluted with water or lime-water. This author has reported seventeen cases of membranous laryngitis following measles, cured by this treatment. The inhalations were usually kept up for fifteen minutes at a time, and repeated every hour or two hours.

The antiseptic qualities of glycerin are sometimes sufficient to overcome the fetid odor so frequently exhaled by patients laboring under ulcerative affections of the palate and pharynx.

OLIVE OIL.

Dose.—Ten to thirty drops, with from five to fifteen grains of gum arabic, in emulsion, to the ounce of water.

An emulsion of olive oil has been employed as an emollient in catarrhal inflammations, in dry cough, especially the cough of phthisis, in whooping-cough, and in bronchitis. (Fieber, Leiblinger.) It has been occasionally employed in emphysema and asthma. (Lewin.)

ALMOND OIL.

Dose.—Same as olive oil.

The expressed oil of almond has been used in the same affections as olive oil; and also in irritable coughs. (Lewin.)

COD-LIVER OIL.

Dose.—Same as olive oil.

Cod-liver oil has occasionally been employed in phthisis. It impregnates the air of the apartment too unpleasantly to be much used in private practice.

* Der Croup und seine Behandlung durch Glycerin-Inhalationen. Manheim, 1870.

GUM ARABIC.

Dose.—Ten to thirty grains to the ounce of water.

Gum arabic has been recommended in the same affections as the oleaginous emulsions. (Leiblinger.)

TABLE SALT.

Dose.—One to twenty grains to the ounce of water.

One of the most efficient remedies for use by inhalation is common table salt. It is the chief sensible ingredient in many mineral waters, and probably the main remedial agent in the combination ; the water, perhaps, excepted. It is very useful in catarrhal inflammations of the air-passages generally, promoting resolution, and acting as a mild stimulant and detergent.

It was first used extensively by Waldenburg, who attributes to it all the good effects produced by the inhalation of the various mineral waters in which it is a prominent constituent. Siegle also has used it extensively, and corroborates the observations of Waldenburg. Beigel sets the apparatus in different parts of the room, so as to get up a sort of artificial sea air in the atmosphere for a time ; and he recommends it by inhalation, as affording great relief in all stages of consumption.

Lewin employs it in small doses to relieve cough and promote expectoration.

Liebig recommends it (in combination with tannin) in chronic catarrhs with difficult expectoration.

Waldenburg* considers table salt indicated principally in chronic catarrhs of the pharynx, larynx, trachea, and bronchi. He considers it the most useful of all remedies, in dry catarrhs especially ; as it not only excites

* Op. cit., p. 261.

the failing secretion, but at the same time diminishes the tumefaction of the mucous membrane. It is likewise useful, in large doses, in emphysema and asthma resulting from chronic bronchitis. Waldenborg states, however, that salt is not to be recommended in acute catarrhs, nor in the acute exacerbations of chronic catarrhs, as it irritates the mucous membrane, and thus does injury more frequently than service.

This remedy, in moderate doses, is highly extolled by the same author in many cases of pulmonary consumption ; in torpid cases, chronic in their course, with little secretion, and no disposition to acute exacerbations of caseous pneumonia. In these cases, not only does it produce the local effects above mentioned, but it increases the appetite, and this, with the thirst excited, leads to the increased consumption of liquid and solid nourishment.

Lewin* closes his record of cases of phthisis treated by the inhalation of sprays with one of tuberculosis of the larynx and lungs, in which the positively beneficial result of salt was remarkable, inasmuch as the tuberculous process in the lungs underwent retrogression.

Judge K., of Bromberg, æt. 39, of slender build, feeble constitution, and phthisical diathesis, is the offspring of healthy, sturdy parents, still living. His mother, however, suffers from cough. He has three sisters, and they are healthy. Of the exanthemata, he has had only searlet fever in his seventh year.

In 1841, after great exertion and exposure to cold, he contracted a "gastrie nervous fever," from which he recovered after a period of six weeks, but of which he soon had a relapse which lasted another six weeks. Since this time he has remained weak and feeble.

His present illness is attributed to an overheating followed by a

* Op. cit., p. 45.

cold, during an exhausting official sitting in 1855. The disease set in with chill, heat, fever, considerable cough, and subsequent emaciation. He then sought recuperation at Reinerz, where, by the use of its tepid springs, with the use of whey, he became tolerably well again. While travelling, in the following year, 1856, the cough returned, and had since remained permanent without alteration.

In the summer of 1862, the patient sought the mineral springs at Ems, and not without some benefit; but fourteen days after the treatment at that place had been discontinued, there set in a hoarseness with occasional small, lumpy, bloody expectorations.

Soon after this he began to experience great difficulty in swallowing his food, so as to render the process very uncomfortable, and "he sate himself to his meals very reluctantly." The pain was felt principally during the first and third portions of the process of deglutition, and also by the passage of the bolus over the ulcerated epiglottis on one side, and the inflamed arytenoid cartilages on the other.

Present condition, June 2d, 1863: The pitch of the voice is high, attenuated, and weak. The soft palate is redder in color than is normal. On the right side are many relaxed veins extending as far as the uvula.

The circumvallate papillæ are much enlarged, and project in a button-like manner. On the right side of the root of the tongue is a threadlike vein with lateral varicose branches, extending almost to the anterior attachment of the epiglottis.

The follicular glands are more swollen on the right side, less prominent on the left. Two very full glands, superficially ulcerated, are seen upon the glosso-epiglottic ligament.

On the anterior border of the epiglottis, particularly the left side, extending beyond the middle line, is a loss of substance with the tuberculous characteristics. The border of this defect of the epiglottis shows a small swelling on its free extremity where it approaches the sound portion of the left side, and, rather more upon the inferior surface, a button-like excrescence. The inferior surface of the epiglottis in the neighborhood of this defect is yellowish and cicatrized, and the protuberance of the epiglottis can scarcely be seen.

The ary-epiglottic fold is more swollen on the right side, and there is a small cicatrix upon the left one. The mucous membrane of the arytenoid cartilages is so oedematous from infiltration that it

cuts off almost completely the view of the vocal cords, permitting only their anterior attachments to be seen, at which point their color is reddish livid.

The false vocal cords are dark-red in color, and very much swollen, and on the right one there is a superficial erosion.

The anterior wall of the trachea, as far as can be seen, is colored as from a recently contracted catarrh.

The larynx is painful to pressure. The neck is small, thin, and long. The contour of the thorax is flat, depressed, and paralytic. On the right side, beneath the attachment of the clavicle to the sternum, is a longish depression, and the whole region beneath the right clavicle is sunken in. Inspiratory elevation but slight. The panniculus adiposus gone.

Percussion in the right supra-clavicular region elicits a dull, empty sound; on the left side, it is normal. In the internal supra-clavicular region of both sides, the sound on percussioñ is alike, and normal; externally, on the contrary, it is clearer upon the right side than on the left.

In the intrascapular region the sound on percussion is dull on the right side; otherwise everything is normal.

Cardiac dulness rather increased.

Auscultation reveals anteriorly in the left supra-clavicular region, undoubted sonorous râles in the apex of the lung. On the right side, undetermined respiration. Vocal vibration and fremitus stronger over the right thorax than over the left.

Puerile respiratory murmur posteriorly, but much weaker on the right side than on the left.

The patient inhaled, during six weeks, at first common salt alone; later with the addition of the bicarbonate of sodium, both in the same proportion, gradually increased to half an ounce to twenty-four ounces of water, to which at times a little tincture of opium was added. The beneficial effect was not temporary only, it was continuous; and to-day (reported in 1865) the patient still remains comparatively well, and pursues his laborious avocation in K—.

CARBONATE AND BICARBONATE OF SODIUM.

Dose.—One to ten or more grains to the ounce of water.

These remedies are emollient and resolvent, the bicar-

bonate being the milder of the two. They are indicated in acute catarrhal inflammations of the respiratory tract, and in the acute exacerbations of chronic inflammatory affections; and they are often administered to better advantage at a warm temperature. They are said by Waldeburg to be of great use in acute tonsillitis, hastening suppuration and rupture of the abscess. The same author considers their most prominent indication to be in cases of parenchymatous or so-called granulous pharyngitis.

They are also employed with advantage in chronic catarrhs with tenacious viscid secretion, including cases of chronic and fetid coryza.

Gerhardt has employed inhalations of bicarbonate of sodium in valvular disease of the left side of the heart, as well as in recent catarrhs of the air-passages. In cardiac affections he employs a solution containing from one-half to one and one-half per cent. of the salt.

CARBONATE OF POTASSIUM.

Dose.—One grain to one drachm to the ounce of water.

This remedy is similar in its action to the carbonate of sodium, and is employed in the same affections. It is recommended in recent laryngeal and bronchial catarrhs, and in follicular pharyngitis. (Siegle, Lewin.)

It has likewise been employed in pneumonia, whooping-cough, and membranous croup.

CHLORIDE OF AMMONIUM.

Dose.—One grain to a drachm to the ounce of water.

This is one of the most useful remedies, and may be employed in almost all instances in which it is desirable to promote secretion. It has also an alterant and ab-

sorbent influence upon tumefactions of the glands, submucous connective tissue, and the mucous membrane.

It is used in acute catarrhal inflammations of the larynx and bronchi (Siegle, Lewin, Gerhardt, Waldenburg), in acute exacerbations of chronic catarrhs (Waldenburg), in chronic catarrhs with difficult expectoration, in acute and chronic eoryza, and in emphysema and asthma resulting from chronic bronchitis (Gerhardt, Waldenburg). It has also been recommended, in combination with table-salt, in phthisis (Gerhardt), though usually considered contraindicated in that disease, even merely to promote expectoration, especially when there is any disposition to haemorrhage from the lungs.

Waldenburg especially recommends the formula following, in superficial catarrhal inflammations of the pharynx, larynx, trachea, and bronchi: twenty-five parts of muriate of ammonia dissolved in one hundred parts each of distilled water and glycerin, of which one to two tablespoonfuls in a wineglassful of water is used at each inhalation.

I have found the muriate of ammonia a very useful remedy in the dry variety of chronic pharyngitis, pharyngitis sicca; and in a number of cases occurring in shopkeepers, prompt relief has often soon followed its employment, three times a day, at the place of business,—before opening the store, at noon, and before closing. I have seen the like good results in bronchitis sicca also.

Siegle states* that, in acute catarrhal laryngitis, after the severer symptoms have subsided, when the main object is to facilitate the expectoration, he has found the greatest advantage from a solution of four grains of sal

* Op. cit., p. 53.

ammoniae to the ounce of distilled water, several times a day, the patient sitting in close proximity to the apparatus.

CHLORATE OF POTASSIUM.

Dose.—One to fifteen grains to the ounce of hot water.

Chlorate of potassium is frequently used in spray, for all those purposes for which it has long been used in the form of a gargle. Thus, in the aphthous conditions of the mouth (Siegle, Lewin), in noma, canerum oris, in aphthous processes in the pharynx and larynx (Waldenburg), in pharyngitis (Lewin), tonsillitis, in sore throat in general, and in ptyalism from mercury. It is also recommended in diphtheria by Lewin, who has recorded in detail* eighteen cases of diphtheria treated by him, in part with inhalations, chiefly of chlorate of potassium; of which number fifteen recovered.

These cases were pharyngeal diphtheria chiefly, the larynx being little or not at all affected; except in one instance, in which it was severely implicated.

Very few physicians would be willing to place any reliance on chlorate of potassium as the chief medication in diphtheria.

CHLORINE.

Solution of Chlorinated Soda.—*Dose.*—From five minims to a drachm to the ounce of water.

Chlorine Water.—*Dose.*—Five to twenty minims to the ounce of water.

These will be found useful applications in all affections of the mouth, nostrils, and air-passages, attended with fetor. I have sometimes found chlorine water the

* Op. cit., pp. 466-499.

only effectual corrective in some cases of chronic fetid coryza. The solution of chlorinated soda has been recommended in bronchitis, with offensive and copious secretion, and also in phthisis by Da Costa, who likewise recommends the employment of the diffused spray as a disinfectant. In a letter upon this point, from that gentleman (1866), he has written me: "Having had a good deal of facial erysipelas brought into the wards at the Pennsylvania Hospital, and two cases subsequently developing themselves there, I used chlorinated soda. In a few minutes the whole ward was filled with the odor of chlorine, and during the whole day and evening the particles of soda burn flickeringly in the lighter gas with their characteristic yellow flame, a good proof of diffusion. Surely, to disinfect rooms, etc., there is nothing better."

Solutions of chlorine are sometimes used in the treatment of pulmonary gangrene.

In relation to this affection, Dr. Beigel states* that when he was physician to the spa of Reinerz he remembers some individuals who had visited that resort in the hope of procuring relief from the fetid odor of their breath; and he relates the case of a young Russian, æt. 21, who had been subject to phthisis for years, and in both of whose lungs there were signs of large cavities.

"The breath of this patient was so fetid that he found great difficulty in securing apartments. He was made to inhale a solution of chloride of lime (one drachm to the ounce), which did not cause any cough; and though its effect was unmistakable, chlorinated water (one part to six parts of water) was substituted, which made the patient's condition much more tolerable. He inhaled nearly every hour, and almost from the first inhalation the im-

* Op. cit., p. 190.

provement was so marked that one could remain with him a quarter of an hour or more, which before had been impossible."

PERMANGANATE OF POTASSIUM.

Dose.—One to ten grains to two ounces of water.

The spray of a solution of permanganate of potassium was employed by Reveil to disinfect tainted atmosphere, by nebulizing a solution containing a large teaspoonful to two and three-quarter pounds of water. He also employed from ten to thirty drops of the solution per diem in pharyngeal diphtheria. I have found this remedy valuable as a detergent and astringent in ulcerative tonsillitis, and other suppurative affections of the throat; using just sufficient of the salt to tinge the water in which it is dissolved.

It is useful in fetid coryza; and is indicated in aphtha, diphtheria, putrid bronchitis, and pulmonary gangrene; and likewise in cases of fetid ulcerations of the pharynx and larynx, of whatever origin. I have used it locally with good effect in the anginose forms of scarlatina, one instance being the most threatening one that I ever saw recover.

IRON.

Solution of Chloride of Iron.—*Dose.*—One to thirty minims to the ounce of water.

Sulphate of Iron.—*Dose.*—Half a grain to ten grains to the ounce of water.

Iron is used both as an astringent and as a styptic; but must not be continued for too long a period, as its prolonged use is apt to impair the appetite. Its chief employment is in severe haemoptysis (Hillairet, Zdekauer, Lingen, Lewin, Waldenburg, Siegle, Wedemann,

Leiblinger, Fieber, Da Costa, and others). One drop of the officinal solution to the ounce of water is often sufficient to restrain a moderate haemorrhage; but in severe haemorrhages the larger doses are sometimes requisite. It is likewise employed as a styptic after amygdalotomy; and as an astringent in chronic pharyngitis, laryngitis, and bronchitis, with excessive secretion (Gerhardt, Lewin, Da Costa). My own experience with iron in the last-named affections has not been at all encouraging. Iron has been recommended in the earlier stages of phthisis (Lewin, Da Costa); but according to some (Lewin), it is contraindicated in the phthisis of delicate females, accompanied with fever and irritability of the mucous membrane. Lewin employed it with good result in a case of pharyngo-laryngitis, with occasional aphonia; and it has been recommended by Da Costa as a weak inhalation in hysterical aphonia.

Dr. Wedemann, of Jena, assistant in the clinic of Prof. Gerhardt, has reported* a case of whooping-cough in a child seven years of age, in whom the intensity of the spasms of cough began to diminish after the very first inhalation of a solution of the sesquichloride of iron, three drops to the ounce of water.

Success in its use has furthermore been reported in pulmonary gangrene (Gerhardt), and in croup and diphtheria (Lewin).

The solution of the sesquichloride of iron is the remedy most frequently resorted to in haemoptysis, on account of its well-known haemostatic property, coagulating the fibrin of the blood into an insoluble clot, and thus preventing further escape of the blood. It is also

* Op. cit., p. 42.

absorbed by the bronchial mucous membrane, and is thus to be used in cases of anaemia, with an ulterior view as to its ordinary therapeutic effect. It is to be resorted to in threatening cases, but is contraindicated in the febrile states of phthisis, and in delicate individuals with great sensitiveness and irritability of the mucous membrane. Lewin mentions the case* of a lady in whom the inhalation of a solution of the sesquichloride of iron employed for a profuse bronchorrhœa always induced a slight haemoptysis, even when in the proportion of but half a drop of the solution of chloride of iron to the ounce of water. I have encountered a similar result when employing the remedy to restrain haemorrhage.

In using these ferruginous inhalations, care must be taken to protect the teeth.

Lewin suggests the possibility of the iron exciting a plastic exudation in a pulmonary cavity, the same as when injected into the sac of a hydrocele, and the like.

The strength of the solution used for the purpose of arresting haemoptysis varies considerably with various authorities. From two to five grains to the ounce is ample, for a small proportion of iron will coagulate a large quantity of blood. Prof. Zdekauer employed a draehm to six ounces of water; half of which quantity was inhaled at each sitting by means of Mathieu's instrument. And by the way, the instrument of Mathieu, if at hand, or the insufflator of Bergson with the double bulb, on account of the low temperature of the spray they produce, are preferable in these cases to the steam apparatus. In cases of great danger, where the patient's strength must be economized to the utmost, the propor-

* Op. cit., p. 348.

tion of iron in the solution can be increased, in order to diminish the time of inhalation.

It must not be forgotten that many pulmonary haemorrhages cease promptly without the introduction of a haemostatic; which fact renders it difficult, in ordinary cases, to judge of the exact value of the inhalations.

That ferruginous inhalations have often saved life by promptly arresting haemoptysis, and keeping up contraction of the bloodvessels, has been abundantly attested by the records of many hundred cases from the pens of various observers.

One or two striking examples are introduced in illustration :

Fieber* relates a remarkable case in a man whose whole family were predisposed to affections of the respiratory organs, and several of whom were suffering from pulmonary and tracheal troubles. About fifteen years previous, the patient, at that time twenty years old, while journeying in winter, was attacked with haemoptysis and pneumonia. Various treatment had been employed for the cough, etc., without success. Dr. Wagner became acquainted with the patient in 1860. At that time he had an exceedingly severe cough, with profuse bloody expectoration. The apices of both lungs were infiltrated with tubercles, the right one to a very great degree. The sound on percussion was dull, and the respiratory murmur almost entirely bronchial. The region under the right clavicle became more and more sunken in, slight pains in the right thorax and under the right shoulder-blade were complained of, and the patient emaciated greatly. Whey, cod-liver oil, and mild narcotics with quinine, were of benefit, so that after a while the patient felt like travelling and resuming his employments, but desisted from so doing on account of his catarrh and slight attacks of haemoptysis. In the year 1861, the patient complained of a sense of weight in the right loin and the right testicle, which latter organ was enlarged, hard, uneven, and painful on pressure. This was attributed to strain at stool. All the emollient, soothing remedies,

* Op. cit., p. 141.

in connection with rest, etc., produced no effect. The diagnosis pointed to tuberculous infiltration. A suspensory had to be worn. The patient's appetite was always moderate; bowels constipated, requiring laxatives. He would lose flesh and regain it, and lose it again. Continued speaking and physical fatigue were very well borne. Early in December, the bronchial catarrh exacerbated and increased to a very great degree. At the same time he became subject to attacks of haemoptysis of such vehemence that his life was in constant danger. This condition had continued, in spite of all remedies, for more than five weeks, when, on the 9th of January, inquiry was made of Dr. Fieber whether *it would be possible by means of inhalations to keep the patient alive for three or four days* to see his brother, whose arrival was expected at that time. Fieber found the patient in a state of great helplessness, hardly able to move himself, and barely able to converse. A thorough examination—which would have been superfluous—was impossible. All sorts of remedies had been so ineffectual that the patient had discarded medicine, and contented himself by sucking enormous quantities of small pieces of ice. On the day, on the evening of which the inhalatory treatment began, four pints of blood were expectorated. With little hope of good result, the inhalation was begun that 9th of January, the greatest care being necessary for fear of exciting even a moderate paroxysm of cough, which would have resulted in a haemorrhage which might have proved fatal. A solution of the sesquichloride of iron (which, by the way, had been given by the stomach with no better effect than anything else), two scruples to two pounds of spring water, was placed in the second model of Charrière's apparatus, and only such pressure exercised as absolutely necessary to nebulize the fluid. The patient was permitted to inhale this so cautiously that a quarter of an hour's rest was allowed after every fifth inspiration. Three such sets of inspirations were given in the forenoon and the like number in the afternoon, so that he took, daily, thirty inspirations. The number was subsequently increased to forty-eight, and the proportion of the iron increased to a drachm. The result was a happy one. On the 10th of January, the patient expectorated only one pint of blood. The sputa remained bloody until the 14th, *and after that, they continued free from tinge.* The patient was of a very irritable temperament, and every irritation induced congestion to the lungs. This was the reason that later, after any considerable emotion, the sputa became tinged with blood, though

this would quickly disappear. On the 1st day of February, a narcotic solution was substituted for the ferruginous one, in order to diminish the catarrhal phenomena. At the end of April, the inhalations were discontinued. The strength of the patient, meanwhile, had so increased that he was subsequently able, in the beginning of June, to travel to Roznan, for the purpose of undergoing the whey-cure; and there Dr. Polansky resumed the inhalations, employing tannin. Dr. Fieber saw the patient again at Vienna, in August; he had improved very much in appearance, and was about departing for Berlin to rejoin his relatives.

Zdekauer reported* a remarkable case of arrested haemorrhage, in which the presence of iron in the lung was demonstrated after death. This case is detailed by Lewin,† and is as follows:

J. B.—, an invalid soldier, was sick with Bright's disease, with albuminuria and consecutive dropsy. Close examination revealed the existence, at the same time, of hypertrophy of the heart, and either insufficiency of the mitral valve, or atheromatous exsiccation in the aorta. The diagnosis was difficult on account of the pressing upwards of the diaphragm by aseites; and the short, but rough respiratory murmur was so loud and difficult to restrain, that only an occasional systolic murmur could be heard; while percussion elicited the existence of an enlargement of the heart.

Milk, diuretics, nitrate of potassa, and other remedies, were all ineffectual. The dropsical exudation and effusion increased rapidly; the patient could only breathe when sitting in an arm-chair. One day he was attacked with suffocation, followed by a terrific haemorrhage, which seemed to have no disposition to cease.

The apparatus of Mathieu happened to be at hand, as well as a solution of the chloride of iron, so that the resort to inhalation was made immediately. The poor patient just about breathed, or rather gasped for breath, and in two minutes he had fainted. He was soon restored to consciousness by sprinkling cold water upon his face, and he was made to inhale the solution for two minutes, when the haemorrhage ceased as if cut off short; but it had exhausted the remaining strength of the patient, who died two days after with suffocative phenomena.

* Wien. med. Woch., 1861.

† Op. cit., p. 240.

Autopsy. Bloody serous exudation in the right pleural cavity, floating the lung. In the right lung several insulated blood-clots, of very dense consistence, and not bloody when cut into. In the left lung, similar blood-clots, but much smaller. The heart hypertrophied and covered with fat. Atheromatous deposit in the ascending aorta; insufficiency of the mitral valve. The left kidney much degenerated, the right one less so. Serous infiltration everywhere.

Dr. Holm examined the blood-clots, and found, in all parts of the lung-structure, iron in much larger quantities than could be attributed to the iron of the blood.

It is an important fact, that this very haemorrhage, which arose from great stagnation of the blood and regurgitation into the vessels of the lungs, was arrested by the inhalation of a watery spray containing chloride of iron, and that the deep penetration of the solution into the very bleeding tissue of the lung could be demonstrated on the corpse.

Subsulphate of iron has the same uses as other salts of iron, and has been recommended by Da Costa in haemoptysis.

ALUM.

Dose.—One to twenty-four grains to the ounce of water or some aromatic infusion.

The weaker solutions are astringent; the stronger ones are styptic.

Alum is used in inhalation in superficial catarrhal inflammations of the palate, tonsils, pharynx, and upper air-passages. These inhalations are not applicable to the very early stage of acute inflammation, though Waldenburg admits their utility when it is probable that the disease can be aborted by their early use; but when the stage of secretion has become established they are often of efficient service, especially if renewed every few hours. In high states of inflammation better effects often follow at a low temperature, though many patients prefer that the solution be warmed. If the parts are

painful, as well as swollen, the watery extract of opium, or the like, can be added to the solution with advantage, in the proportion of from one-fourth of a grain to a grain to the ounce. A solution of alum, in coarse spray, is an admirable substitute for the gargle in inflammatory conditions of the palate, tonsils, and pharynx ; and with the horizontal tubes and Clark's bellows can be most accurately applied to the diseased parts. Some patients are unable to tolerate alum at all, while with others it acts, so to speak, like a charm.

I have repeatedly verified the experience of Schnitzler, Waldeman, Fieber, Lewin, and others, as to the effect of astringent inhalations in uncomplicated cases of superficial inflammation of the pharynx and larynx ; and, occasionally, the result has been so prompt as to stagger credence ; and the like of which, certainly, has not attended other treatment. A couple of cases from my notebook in illustration :

C. F. H——n, a stout, hearty driver of an express wagon, contracted an intense laryngitis and pharyngitis from exposure incident to his employment. When he was sent to me, April 6th, 1866, after the disease had existed three or four days, his voice was very hoarse, and he complained of great pain in swallowing. Laryngoscopy revealed intense congestion of the laryngeal mucous membrane, including that covering the vocal cords. He inhaled a nebulized solution of alum during fifteen minutes with great relief, and the following day the pain and dysphagia had left him, the voice was almost natural, and the parts had assumed their normal appearance.

Mrs. F——n applied to me May 1st, 1866, recommended by the express driver, whose case has been mentioned. She had been suffering from sore throat for several days. I found infiltration of the aryteno-epiglottic folds and of the mucous membrane covering the cartilages of Santorini. Inhalations of alum water were administered, and she was directed to take three compound cathartic pills at bedtime. The next day she returned much the better for

her purge and her inhalation. The inhalation of alum was repeated in the evening, and the day following she was sufficiently well to resume her domestic employments and dispense with professional services. Some years afterwards this patient applied to me under similar conditions, and was relieved within twenty-four hours by the same treatment ; but two inhalations being again administered.

Siegle reports having employed inhalations of alum in many cases of acute catarrhal laryngitis, but not with much benefit, unless he dieted the patients and kept them abed. Beigel, on the other hand, reports several cases cured by inhalations of alum.

Inhalations of alum are of great service in chronic inflammations of the palate, pharynx, larynx, trachea, and bronchi, especially in simple catarrhal cases with excessive secretion.

Schnitzler* reports three cases of chronic laryngitis treated with alum, rapid and marked improvement taking place, as shown by laryngoscopic examinations by himself and Dr. Stoerk. Improvement set in at once after the inhalation, and continued for from six to twenty-four hours.

Alum is also used in chronic bronchitis. Da Costa† narrates a severe case cured mainly by inhalations of alum, eight grains to the ounce, with the addition of six drops of the fluid extract of eonium, the alum being gradually increased to the proportion of twenty grains to the ounce. Beigel‡ details a case in which inhalations, night and morning, of a solution containing two grains of alum and ten minims of laudanum to the ounce of distilled water, proved successful after the failure of many other remedies ; and also a case of chronic bronchitis, occur-

* Wiener Med.-Halle, 1862, No. 48.

† Op. cit., p. 34.

‡ Op. cit., p. 121.

ring after small-pox, which succumbed to inhalations three times a day, of alum, one grain to the ounce, with the addition of ten minims of laudanum.

Schnitzler also reports* a case of complete aphonia cured by inhalations of alum. For two years the patient had been subject to recurrent hoarseness, until, some six or eight months before treatment by inhalation, the voice suddenly left, and the aphonia remained constant. The laryngoscope showed marked swelling of the vocal cords, and of the mucous membrane of the larynx generally. Nothing abnormal was detected in the lungs. This physical condition was confirmed by Semeleider. Inhalations of a solution of alum were instituted, and on the second day the voice was louder; and in eight or nine days the patient had recovered a pretty good voice, though hoarse, which became clearer and louder every day. The gradual diminution of the catarrhal swelling of the vocal cords was watched with the laryngoscope.

Siegle† employed inhalation of a strong solution of alum for three days, with partial return of the voice, in a case of hysterical aphonia, of several years' duration, the cure being subsequently rendered permanent by local faradization.

Alum has likewise been employed in whooping-cough.

Siegle‡ reports the cases of two sisters, aged respectively three and five years, in whom the disease had lasted for five days. He employed inhalations of a solution of alum, a drachm to six ounces of water, twice daily, ten minutes at a time. By the night of the very first day the paroxysms had abated in violence, and the

* Loc. cit.

† Op. cit., p. 70.

‡ Op. cit., p. 73.

eases were completely cured; the younger on the eighth day of treatment, and the other a few days later.

Alum inhalations have been recommended in chronic pulmonary phthisis in all its stages (Waldenburg). Waldenburg employs the alum also in combination with tar-water.

It is likewise occasionally used as a styptic in moderate haemoptysis (Tobold, Polansky, Schlesinger, Siegle), especially when occurring in acute inflammatory conditions; being indicated in cases in which it is not desirable to impress the organism with the influence of a remedy which is liable to absorption by the bronchial mucous membrane. It likewise seems to produce a more prolonged effect than iron.

Alum has been recommended in dilatation of the bronchi with excessive secretion (Niemeyer); in putrid bronchorrhœa; in pulmonary gangrene (Trousseau); in croup and diphtheria (Lewin); in laryngeal excrecescences (Siegle), etc. I have found it useful in the sore throats of the exanthemata, having most experience, however, in the sore throat of scarlatina.

Dr. Semeleder, of Vienna, relates* a case of stenosis of the larynx, supervening during the healing of an incised wound, completely relieved by inhalations of a solution of alum.

A woman, æt. 46, endeavoring to commit suicide, cut her throat with a razor, about the position of the upper border of the thyroid cartilage. The larynx was opened close under the epiglottis, and thence the wound communicated directly with the pharynx. The voice was low and difficult, swallowing painful, and on an attempt to drink, some drops would flow down between the arytenoids upon the vocal cords, and thence out of the wound.

* Woehenblatt der Zeitschrift der K. K. Gesellseh. d. Aerzte in Wien, No. 1, 1864; Lewin, op. cit., p. 289.

On the fourth day, an elastic catheter, and over this a double canula of hard rubber, was placed within the glottis through the wound, with relief to respiration and expectoration. After the condition of the patient had gradually improved to a remarkable degree, suddenly, on the forty-ninth day, she was seized with difficulty of breathing, following exposure to cold, accompanied with swelling of the vocal cords, true and false, and the production of a stenosis of the larynx. To relieve this, the inhalation of a nebulized solution of alum in water was employed, beginning with a drachm to a pound of water, and later increased to two drachms with the addition of a few drops of laudanum, in order to retain the astringent effect of the inhalations.

The patient inhaled, once daily, six to eight minutes, the canula being closed. She improved so much that the swelling and congestion of the whole laryngeal structures, as well as the epiglottis, gradually became reduced. Immediately after each inhalation the voice was much louder than it had been before. After three weeks of these inhalations, the glottis had again become so movable that the canula was withdrawn from the wound. The patient breathed freely without the canula, and the voice gradually improved.

Few practitioners would like to trust a case of laryngeal stenosis, acute or chronic, to the remedial agency of sprays.

TANNIC ACID.

Dose.—One to sixteen grains to the ounce of water. Astringent in weak solution; styptic in strong solution.

Tannin is very extensively used by inhalation, usually fulfilling indications similar to those of alum. It appears to be rather better adapted than alum to affections of some continuance. It is used as an antiseptic as well as a styptic and astringent. It is apt to produce a good deal of dryness in the throat and sensations of heat, on which account it is usually best to begin with small doses.

It has been recommended in chronic catarrhal inflammations of the palate, pharynx, larynx, trachea, and

bronchi; in torpid cases of hypersecretion; in bronchorrhœa (Siegle), especially on account of its antiseptic action; in haemoptysis (Polansky, Fieber); in pulmonary gangrene (Troussseau); in croup and diphtheria (Troussseau, Barthiez, Lewin, Fieber); in œdema of the larynx (Troussseau); in polypoid exereenes (Klinbacher); and in spasmodic coughs.

In ordinary chronic sore throat, or catarrhal inflammation of the palate, pharynx, and posterior upper portion of the larynx, an affection of great frequency, and particularly suited to treatment by sprays, I have seen good effects from inhalations of tannin, one grain or more to the ounce, repeated once, or at most twice, a day. It is better to prepare the solution as it is required (to avoid change into gallie acid), and to filter the solution before using it. In my own practice, tannin has yielded better results than alum, though this is by no means a general observation. The remedy comes into play, too, after amygdalotomy. •

Demarquay found great benefit in a dozen of cases of granular pharyngitis from the inhalation of tannin, one part to one hundred parts of water, with the use of the waters of Eaux-Bonnes, where the treatment was instituted.

In general, the condition of the patients improved under the influence of three to four nebulizations a day. Sometimes improvement began in a single day. In from twenty to twenty-five days, he cured a young lawyer, whose voice lost its power on moderate exercise, of a dryness of the throat, with slight but long-continued cough and bloody sputa. Examination of the pharynx showed a chronic inflammation of the entire region, with

a normal development of the pharyngeal glands. Trouseau witnessed this case.

Demarquay, however, does not consider this treatment a radical cure for granular pharyngitis, the cause of which he considers to exist deeper in the organism.

I have little faith in the use of sprays in this variety of pharyngitis.

Dr. Johann Schnitzler* reported a case of pharyngolaryngitis in an individual about thirty years of age. Marked improvement ensued in a few days from inhalations of tannin, five grains to the ounce of water. This was not considered a curable case, inasmuch as the patient would not give up the abuse of spirituous drinks, to which his catarrh was partly attributable.†

The same author reports some successful cases of chronic laryngitis treated in the same manner.

Demarquay reported great improvement from an inhalation of tannin, one part to one hundred parts of water, in a case of laryngeal phthisis, in which deglutition was very painful and almost impossible.

Tannin has been used by inhalation in croup and diphtheria. Barthez‡ details four cases of croup, treated by him at the Hôpital des Enfants, St. Eugénie, with inhalations of tannin, five to ten parts to one hundred parts of water, from eight to twenty times a day, fifteen to twenty minutes at a time. In these cases the effect of the remedy upon the membranous exudation was excellent. Respiration became freer, the dyspnoea diminished, and the suffocative paroxysms subsided. Two

* Wiener Medicinal-Halle, 1862, No. 48, p. 442.

† Lewin, op. cit., p. 259.

‡ *Traitemenit des angines diphtheritiques par la pulverization*, Paris, 1861.

of the cases terminated fatally, in consequence of the systemic poisoning, for in one of the cases where the presence of the membrane had been diagnosed, no trace of it could be found upon post-mortem examination.

The first case, a girl, æt. 4½, was one of general diphtheritis, with pseudo-membranous exudation in the nostrils, upon the lips, in the mouth, larynx, and doubtless in the bronchi. Death occurred on the sixth day after commencing treatment, and the twelfth of the disease. At the autopsy there was no relic of pseudo-membrane anywhere on the tonsils, pharynx, larynx, trachea, or bronchi.

This case showed us, remarks Barthez:

1st. A modification of the local appearances after twenty-four hours, under the influence of the nebulized solution of tannin.

2d. The local improvement the greater, the more the pseudo-membrane came in contact with the nebula.

3d. The corresponding diminution of the general symptoms of diphtheritic intoxication, with the diminution of the local symptoms.

The second case, a boy, æt. 5½, was diphtheritis of the pharynx, larynx, and nostrils. Internal treatment with large doses of sesquichloride of iron, and inhalations of a tannin solution; immediate and permanent benefit by the inhalation of tannin; improvement in the croupal symptoms while the systemic poisoning rapidly increased, and the child died on the twelfth day of the disease, and tenth of the treatment.

The third case, a boy, æt. 3, was one of *angina membranacea*—croup in the second stage. Treatment by inhalation began on the fourth day, with repeated inhalations of a nebulized solution of tannin. For three days the disease remained stationary; then improvement rapidly ensued, with recovery on the ninth day.

The fourth case, a girl, æt. 3½, was one of croup in the first stage, with pseudo-membranous exudation upon the tonsils, the soft palate, and the uvula. Prompt recovery on the fourth day of treatment by inhalation of a solution of tannin.

Fieber,* who, having translated Barthez's cases, treated fifteen cases of his own in the same manner, reports two-

* Op. cit., p. 114; Wiener Medic -Halle, 1862, Nos. 17, 20, 24.

thirds of them cured, the remaining third having terminated fatally. He combats Barthez's opinion as to the mechanical effect of the tannin, which, according to that observer, is to pucker the membrane, so that its edges roll over, and thus effect its gradual detachment; and states that he has never seen this effect, but that the membrane appears to him to become, as it were, dissolved under the influence of the tannin.

Da Costa,* in commenting upon these cases, remarks that when we look at the length of the treatment, it does not look as if the remedy had any marked solvent power, for diphtheritic membranes are not permanent structures, but are very apt to disappear from the circumference to the centre within a week after their appearance; and hence, if we accord any value to the treatment—which, bearing in mind the usually fatal character of laryngeal diphtheria and the grave character of pseudo-membranous croup, we cannot totally refuse to do—we must also admit that the action is not rapid, and not what we might expect from a solvent; nor can we overlook the effect of the water in the combination as a cleansing agent, and as tending to aid in removing and in expectorating the breaking-down textures, for in Siegle's hands the inhalation of pulverized warm water, alone, produced the greatest relief in an apparently hopeless case.

Trousseau† records a severe case of oedema of the larynx promptly relieved by inhalations of tannin.

A woman, æt. 21, who had recovered from puerperal peritonitis six weeks previously, was admitted into the hospital with great

* *Essay on Inhalations*, New York, 1867, p. 30.

† *Clinique médicale de l'Hôtel Dieu*, Paris, 1861, p. 475.

pain in the throat, swollen tonsils, and difficulty in swallowing. The angina, already of ten 'days' duration, increased rapidly in severity, at times impeding respiration to such an extent as to threaten life. Inspiration was accompanied by laryngo-tracheal râles, although respiration was free, and the voice retained its natural tone. The countenance of the patient was like that of one threatened with asphyxia; the pulse extremely small; the submaxillary region tumid and painful. The pharyngeal mucous membrane was very much inflamed, and examination with the finger revealed an œdematosus swelling of the epiglottis and the aryteno-epiglottic folds. The diagnosis was, of course, œdema of the glottis.

Inhalations of a strong solution of tannin from the apparatus of Mathieu were at once instituted, and repeated hourly; under the influence of which the attack moderated, and on the following day there was marked improvement,—but a single suffocative paroxysm ensuing, and that of less intensity,—with greater freedom of respiration, and disappearance of the râles. The swelling of the epiglottis and of the aryteno-epiglottic folds had markedly diminished likewise. The respiration soon became normal, and only a single suffocative paroxysm occurred in twenty-four hours; and in four days the patient left the hospital advanced in convalescence.

Trousseau also reported to the Academy of Medicine another case of œdema of the larynx likewise cured by inhalations of a solution of tannin.

In aphonia from paralysis of the vocal cords, now usually treated by the local application of the electric current, Dr. Klimbacher* employed with success, in addition, inhalations of a solution of tannin.

In one case of aphonia from the inhalation of hot smoke and flame during exposure in a house on fire, I employed inhalations of tannin for the laryngeal trouble, after the more acute symptoms of laryngitis had subsided, and during their employment the patient recovered her voice.

* Fieber, op. cit., p. 119.

In several other cases contracted under the same circumstances, which, under my own observation, were treated by Dr. W. W. Keen, of this city, the same result followed the same treatment. In these cases, however, the relief of the local trouble causing the loss of voice in the first instance, naturally relieved the aphonia.

I have in this way incidentally relieved several apneas dependent on laryngitis, bronchitis, and the like.

Nebulized solutions of tannin have been used in whooping-cough, by Steffen and others.*

Tannin is a favorite local remedy in the ordinary form of chronic bronchitis. Wedemann highly recommends a solution two grains to the ounce, with the addition of one-twentieth of a grain of morphia.

Beigel† details a severe case of chronic bronchitis which he relieved by inhalations, night and morning, of three grains of tannin with two grains of the extract of hyoscyamus to the ounce of distilled water; though he subsequently changed the treatment, on account of the taste of the remedy, to sulphate of iron, four grains to the ounce.

Trousseau speaks of the value of tannin, among other remedies, in pulmonary gangrene.‡

Rühle observed favorable results from the antiseptic influence of inhalations of tannin in the catarrhal inflammations accompanying typhus fever.§

Inhalations of tannin are sometimes employed to restrain haemorrhage in haemoptysis, inasmuch as, like other styptics, it also coagulates the blood, is an astringent, and diminishes secretion. It is said to be less apt

* Schmidt's Jahrb., July, 1866, p. 62. † Op. cit., 124.

‡ Clinique médicale, Paris, 1861, p. 583.

§ Baumgärtner, op. cit., p. 91.

to excite inflammation than iron, and its influence is probably more continuous. It is indicated in the milder cases of haemoptysis, the so-called passive haemorrhages, and when inflammation is present; also in cases where it may not be desirable to introduce iron into the blood; in the bloody sputa of bronchorrhœa, where it comes in play as an antiseptic. It can be administered in larger doses than the iron,—say from ten to twenty grains to the ounce.

EXTRACT OF RHATANY.

Dose.—One to ten grains to the ounce of water.

This astringent is sometimes employed instead of tannin. It was used by Bataille in chronic inflammations of the mucous membranes of the air-passages, and he reports having derived great benefit from it in his own case. It has been recommended by Troussseau in pulmonary gangrene.

ERGOT.

Fluid Extract of Ergot.—*Dose.*—One to ten minimis to the ounce of water.

Ergot is sometimes employed as a haemostatic, in haemoptysis, instead of iron, tannin, or the like.

SULPHATE OF ZINC.

Dose.—Half a grain to ten grains to the ounce of water.

This remedy is used by inhalation for its astringent properties. It admirably supersedes the gargle in chronic inflammations; and has been recommended in cases attended with excessive secretion. (Siegle, Fieber, Lieblinger, Türck, Lewin.)

It is often of use in chronic coryza; but, to be of ser-

viee, the parts must first be eleansed of aecumulated seere-
tion by the douche and syringe. In obstinate cases of
simple elhronie sore throat, with infiltration and thickening
of the mueous membrane, I have seen very satis-
factory results from morning and evening inhalations of
a weak solution of sulphate of zinc, a grain or two, to
two, three, or four ounces of water.

Fieber reports prompt sueeess in aeute eatarrhal laryngitis, from inhalations of sulphate of zinc with the addition of laudanum. The same author also reports* a ease of laryngo-traeheal eatarrh, with almost eomplete aphonia, in whieh the voice soon returned under the inhalation of a solution eontaining six drops of laudanum and six grains of sulphate of zinc to the ounee of water.

Fieber likewise speaks highly of sulphate of zinc in putrid bronehorrhoea. He also reports a ease of chronic bronehitis simulating eonsumption, of twenty-five years' standing, which improved to a marked degree under the inhalation of a solution of sulphate of zinc, five grains to the ounee. This remedy has furthermore been reeommended in emphysema and in hæmoptysis.

SULPHATE OF COPPER.

Dose.—One to twenty grains to the ounee of water.

This salt has likewise been used for astringent purposes in elhronie eoryza, in tonsillitis, in pharyngitis and laryngitis (Vogler), in ulcerative tonsillitis, in ulceration of the palate and pharynx, in ulcerative laryngitis (Da Costa), and in pulmonary gangrene (Tronsseau).

* Op. cit., p. 119.

ACETATE OF LEAD.

Dose.—One to ten grains to the ounce of water.

This remedy is employed as an astringent. It has been recommended in obstinate, troublesome colds, not yielding to other medicament (Beigel); in acute catarrhs of the larynx and bronchi (Fieber), and in pulmonary phthisis, especially in the stage of softening of the caseous deposit, with disposition to diarrhoea (Waldenburg).

CHLORIDE OF ZINC.

Dose.—One-tenth of a grain to two grains to the ounce of water.

This remedy is occasionally employed as an astringent in obstinate inflammations of the pharynx and larynx, not yielding to ordinary remedies. It is a useful detergent in cancerous inflammations of these structures.

NITRATE OF SILVER.

Dose.—One-sixth of a grain to ten grains to the ounce of water.

Nitrate of silver, used as astringent, alterant, and styptic, has been extensively employed in chronic inflammations of the pharynx and palate, and of the upper part of the larynx; and, to a less extent, in analogous affections of the larynx, trachea, and bronchi. It is especially applicable to cases in which there are erosions or superficial ulcerations; but it must not be administered in the stronger solutions without great circumspection, in the presence of a competent attendant; nor at all, according to my own observations, until it is evident that all milder remedies are insufficient. Inhalations of a weak solution of nitrate of silver have been employed

with success in cases of obstinate chronic pharyngitis, including even the dry or non-secreting form. I have had no experience with this agent in spray in the treatment of this affection, except when an accompaniment of the chronic laryngitis of phthisis. It has also been recommended in acute inflammations, but I have had little experience of this kind.

I remember a case of unilateral inflammation of the palate, involving the submucous connective tissue of the anterior portion, and which, though apparently simple in its character, had, by prolonged suffering, pain, and difficulty in swallowing, and the like, reduced the patient very much. In this instance I propelled a spray of nitrate of silver, twenty grains to the ounce, on the parts from a Bergson's apparatus, for a few minutes daily; and in ten days the parts began to heal rapidly, the general health improved, and the emaciated patient soon regained her customary robust appearance.

Nitrate of silver has been recommended in granular pharyngitis (Lewin, Waldemann, Siegle). It is also much employed in chronic laryngitis, for which Lewin has recommended the inhalation of a nebulized solution of nitrate of silver, one to two grains to the ounce of distilled water. I have occasionally essayed this treatment, but its efficacy has not compared with that of local medication, by the sponge, with a strong solution of the salt. In fact, I have found astringents proper, more useful than nitrate of silver in chronic inflammations, unless there be extensive ulceration, under which circumstance the nitrate of silver is often preferable. It must be confessed, however, that I rarely employ nitrate of silver in inhalation, preferring its direct application by brush or sponge to all accessible ulcerations. In the chronic laryngitis of phthisis, I have sometimes seen temporary relief follow inhalations of a weak solution of

a grain or less to the ounce, with repetition of the effects for a long time, even without any marked improvement in the local appearances; the remedy seeming to arrest, for a while, the progress of destruction in the larynx, though incompetent to excite recuperative action. It is doubtful if nitrate of silver is ever curative in this affection. Niemeyer and many others speak favorably of these inhalations in chronic catarrhal inflammations of the pharynx and larynx. They are also highly extolled in chronic bronchitis, and even in pulmonary phthisis. (Gerhardt.)

Dr. Ludwig Joseph,* of Breslau, reports that he has employed inhalations of nebulized fluids in chronic affections of the larynx, bronchi, and lungs, the medicament principally used being solutions of nitrate of silver of various strengths. With Tobold, he has experienced more benefit from them in affections of the bronchi and of the lungs, than in affections of the larynx, where topical treatment can be better carried out, and with more success. The effect of the nebulized fluids in laryngeal complaints is too weak, and not sufficiently energetic. Their mild influence is more applicable to affections of the bronchial tubes, and of the air-cells, where powerful effects are not required.

In chronic bronchial catarrh, with profuse secretion from the bronchial mucous membrane, and in bronchiectasis, he found the inhalation of nitrate of silver of incontestable value. He found it lessen the abnormal secretion from the mucous membrane, stimulate the membrane by its slight irritation, and thus gradually assist the resumption of its normal functions. It seemed

* Deutsche Klinik, May 26th, 1866.

also to tone up the bronchial mucous membrane. The effect was not equal in all constitutions, but best in slow, sleepy, torpid, serofluous individuals. It was well borne in well-founded cases of suspected tuberculosi. Dr. Joseph has treated several cases of frank tuberculosis, demonstrable by physical exploration, in this manner, with the result of diminishing the amount of ulcerative processes, and promoting general improvement. In these cases the general condition of the patients was favorable.

Among others, the following case of chronic bronchial catarrh, with suspicion of tubercle, is of great interest :

P—K—, of Bremen, æt. 29, a merchant, small in build, of delicate frame, well nurtured, came under treatment September, 1864, having failed to obtain relief from his disease from various remedies that had been judiciously employed. He was made to inhale a solution of nitrate of silver, five grains to the ounce of water; and within three weeks the expectoration ceased entirely, and at the date of writing, twenty months thereafter, there was not a trace of cough or of expectoration.

Dr. Joseph has never seen any direct injury from the inhalations of these solutions of nitrate of silver. At the first sittings the patient feels an irritation along the course of the trachea, continued sometimes as far as the xiphoid process of the sternum,—a feeling of rawness. Immediately after the inhalation a quantity of thick tenacious secretion is often expectorated with ease.

He reports a case of bronchiectasia (dilatation of the minuter bronchi), in which the most remarkable improvement followed the inhalation, for six weeks, of solutions of nitrate of silver, gradually increased in strength to a scruple of the salt to the ounce of distilled water.

Dr. Rohn,* of Hanau, was led to the employment of inhalations of a solution of nitrate of silver in whooping-cough, in consequence of the results of several laryngoscopic examinations of adults and larger children, while suffering with this affection. He found the mucous membrane covering the anterior wall of the lower portion of the laryngeal cavity and the commencement of the trachea, hyperemic in a marked degree, the vocal cords sparkling white and in marked contrast to the intense red of the subglottic region. He therefore considers that the lower laryngeal surfaces, and the commencement of the trachea and the upper portion of the trachea, are the seat of catarrhal inflammation during the spasmodic stage of whooping-cough; and he is confirmed in this view by the uniform statements of adults and larger children, that a peculiar severe irritation about the upper part of the windpipe precedes the spasm of cough which it excites. Dr. Rohn inquires whether the existence of the catarrh at this point is not the true cause of the peculiar paroxysms of cough; and whether the irritation of the inferior laryngeal nerve, which is composed of sensory fibres, will produce the same result with irritation of the internal filaments of the superior laryngeal nerve. Concluding, therefore, that the commencement of the spasmodic affection might also be due to a catarrhal condition of the mucous membrane of the central and smaller bronchi, he resorted to the therapeutic effect of inhalations, in order to reduce the inflammatory process by a local caustic action. He has convinced himself that such treatment resulted favorably in the cases of six children over four years of age, and in two grown persons. The

* Wien. med. Wochenschrift, xvi, 52, 53, 1866.

medicament was a solution of the nitrate of silver, from half a grain to a grain to the ounce of distilled water, according to the age of the patient, and the severity of the affection. About half an ounce of the solution was inhaled once daily. All these cases were of from three to five weeks' duration, and either in the beginning of the convulsive stage, or at its maximum. Dr. Rohn stated that after the first two, and at the furthest, after the first three inhalations, the cough became markedly diminished in violence and duration, and in all of them with an immediate abatement of the vomiting; that after the fourth and sixth inhalation, the general characteristic whooping-cough symptoms disappeared; leaving behind, at the most, but a slight simple catarrh. A still further experience convinces the investigator that at least with children over four years of age, who can be very well made to take the inhalations, other febrile complications of the respiratory organs do not contraindicate the inhalatory treatment.*

In administering inhalations of nitrate of silver, care must be taken that deep inspirations are avoided when the remedy is being employed for affections of the pharynx and upper air-passages, so that the remedy be not drawn too deeply into the respiratory tract. The mouth speculum, a face protector, or a mask should be used to prevent discoloration of the face. Waldenburg recommends† smearing the surface around the mouth, before inhalation, with any ointment composed of any indifferent grease (such as butter, lard, cold cream, and the like), and table salt.

* Schmidt's Jahrbücher, Nov. 1866, p. 57. † Op. cit., p. 243.

NITRATE OF ALUMINIUM.

Dose.—One to five grains to the ounce of water.

This remedy is applicable to the same affections as nitrate of silver. It was introduced into practice by Beigel, who prepared it from a simple solution of aluminum in nitric acid, agitating the crystals repeatedly in distilled water, condensing the solution by evaporation, and recrystallizing.

Beigel reports great service from its use, not only in inflammatory affections, but also in nervous affections of the larynx and trachea.

CORROSIVE CHLORIDE OF MERCURY.

Dose.—One-twelfth of a grain to two grains to the ounce of water. (Siegle.)

Inhalations of the bichloride of mercury are employed chiefly in syphilitic affections of the pharynx and larynx (Demarquay, Schnitzler, Waldenburg, Lewin, Siegle, etc.), and they are even said to be effectual in obstinate cases which resist the internal or hypodermic administration of the same remedy. They have likewise been employed in cases of syphilitic excrencences. (Siegle.) Besides its specific action, this remedy has an astringent and absorbent effect which can often be utilized in non-specific affections. In certain chronic, often ulcerative inflammatory (so-called serofulous) affections of the pharynx and larynx, which resemble syphilis, and which, if not really syphilitic, certainly yield to anti-syphilitic treatment, inhalations of the spray of corrosive sublimate will frequently be found of the greatest service.

Syphilitic sore throat has been treated with good results by Briau, Demarquay, Schnitzler, Waldenburg,

Lewin, and others by inhalations of corrosive sublimate one or two grains to the ounce of water. According to my own experience, the internal administration of anti-syphilitic remedies is much more prompt in its good effects. Soothing inhalations afford relief and keep the parts cleansed just as in non-specific sore throat. Some of the authors named, however, attribute a local specific action to the mercurial, and report its successful employment topically, after failure by internal administration.

Dr. Johann Schnitzler* reports two cases of syphilitic ulcerations of the naso-pharyngeal space, and of the larynx, very quickly cured by inhalations of a solution of corrosive sublimate, a grain to the ounce. The cleansing of the ulcerated surfaces could be demonstrated with the laryngoscope after each inhalation.

Demarquay† found rapid improvement in syphilitic affections of the soft palate, the pharynx, and the larynx, under the influence of nebulized solutions of corrosive sublimate, 25 centigrammes to 500 grammes of water, which he found the best of all topical remedies, in connection with internal treatment. The inhalations were taken three to four times, and each time from five to six minutes in duration.

In several cases he saw very circumscribed mucous patches of these parts disappear rapidly. He remarked this particularly in an old man who suffered with great hoarseness, and on whose palatum molle there were such mucous patches. A general treatment previously instituted had afforded no relief, but the patient improved promptly under the new method.

* Op. cit.

† Op. cit., Lewin, p. 223.

Trousseau* mentions the value of inhalations of corrosive sublimate in pulmonary gangrene.

Inhalations of the bichloride of mercury should be managed with great circumspection, and care be taken that the inspirations are not too deep.

The biniodide of mercury is sometimes used in syphilitic and quasi-syphilitic affections of the larynx and pharynx. Waldenburg recommends it in so-called herpetic pharyngitis, as an astringent, in doses of from one-tenth of a grain, to a grain, to the ounce of water, with five times its weight of iodide of potassium.

ARSENIC.

Solution of Arsenite of Potassium.—Dose.—One to ten drops in one or two ounces of water.

Arsenic has been employed by inhalation in spray in nervous asthma (Trousseau, Wistinghausen, Lewin), in emphysema, in pulmonary gangrene (Trousseau), and in chronic bronchitis; the preparation chosen being usually the well-known Fowler's solution.

It has also been occasionally employed in tuberculous phthisis, and has been recommended in cardiac neuralgia. (Anstie.)

Wistinghausen† reports the following case of emphysema and asthma cured by inhalations of Fowler's solution of arsenic:

A young girl, æt. 15, whose mother had died of tuberculosis, had suffered from childhood with laryngeal and bronchial catarrh, eventuating in emphysema of both lungs with asthmatic paroxysms.

* Clinique médicale, Paris, 1861, p. 583.

† Petersburger med. Zeitschrift, 1862, xvii, p. 137, quoted by Lewin, op. cit., p. 242.

After the employment of a great variety of remedies, external and internal; after a residence during three summers at Wielbach, Ems, and Salzbrunn; and the resort to local gymnastics during two winters—all without beneficial result—she was, at the suggestion of Prof. Eck, placed under the treatment by inhalation of Fowler's solution of arsenic, ten, fifteen, or twenty drops to the ounce of distilled water, once or twice a day. The same remedy had been administered inwardly without advantage, as had also one-twentieth to one-fourth of a grain of nitrate of silver, four times a day. After ten days of inhalation (ten minutes each day) the asthma ceased entirely, and, the inhalations being continued, did not return during the severe and cold winter and the variable spring of 1861. The patient could expose herself in all weathers without using the respirator, with which until then she had been unable to dispense, even during a short promenade. She could also join in the dance until late at night without any trace of shortness of breath, though before this treatment the very excitement of receiving an invitation to a company would bring on a severe attack of asthma. The auscultatory phenomena had not altered much, the mucous sibilant râles having subsided only in the right scapular region.

The patient had inhaled in all four ounces of the Fowler's solution, without any symptoms of arsenical poisoning. After this, she inhaled tannin, ten grains to the ounce, and after a time, extract of pine (Turion) in the same proportion, thirty drops at each time. Sales-Girons's apparatus was employed. Mathieu's instrument was employed once, but was uncomfortably cold.

Lewin, also, recommends the use of Fowler's solution of arsenic, from half a scruple to half a drachm to twelve ounces of water. He relates* several cases in detail which he subjected to this treatment with benefit. Sometimes he added some common salt to the solution. He also, and occasionally with benefit, used the oleo-balsamic mixture, a drachm to half an ounce of castor water.

IODINE.

Tincture of Iodine.—Dose.—One to twenty drops to the ounce of water.

* Op. cit., 442-446.

Iodide of Potassium.—*Dose.*—One to ten grains to the ounce of water.

Compound Solution of Iodine.—*Dose.*—One to thirty drops to the ounce of water.

Compound Tincture of Iodine.—*Dose.*—One to thirty drops to the ounce of water.

These preparations are employed in chronic inflammatory affections of the pharynx and air-passages, whether simple, catarrhal, serofulous, or syphilitic. They are chiefly applicable to affections implicating the glandular structures, so-called granular and follicular sore throats (Siegle); also in cases of induration and thickening of the mucous membrane itself (Lewin), and in infiltration of the submucous connective tissue. They are also useful in the chronic laryngitis of phthisis, and have been employed with advantage in chronic bronchitis with emphysema, and in pulmonary phthisis.

In persistent forms of ordinary chronic pharyngitis, which have resisted treatment with astringents, I have frequently employed a solution of iodine, a few drops of the compound solution to the ounce of water, with advantage.

In the chronic laryngitis of phthisis, both follicular and ulcerative, I have frequently derived great benefit from inhalations of the compound solution or compound tincture of iodine, a few drops to the ounce, with the addition of one or two drops of the concentrated solution of carbolic acid, or one or two grains of the crystals. The same remark applies to analogous affections in serofulous subjects.

I have likewise seen a good deal of benefit occasionally from inhalations of a weak solution of iodine, with and without the combination of iodide of potassium, in

emphysema from chronic bronchitis; and likewise in uncomplicated chronic bronchitis.

Da Costa recommends the compound solution of iodine in chronic bronchitis; and Waldenburg in syphilitic laryngitis.

If pain be complained of, sedatives or narcotics, such as opium and conium, may be appropriately added to the solution; but preferably in minute quantities.

BROMINE.

Bromide of Potassium.—*Dose.*—One to ten grains to the ounce of water.

Bromide of potassium acts as a sedative and as a resolvent. It is indicated in cases of irritation and pain; and although it does not produce the local anaesthetic effect at one time entertained, it certainly often diminishes hypersensitiveness of the mucous membrane. It has thus been employed in spasmodic coughs of various kinds, especially the so-called hysterical coughs, in relieving which its sedative influence on the nervous system is perhaps co-operative. It has likewise been recommended in whooping-cough, by Gerhard and others.

Dr. J. Winthrop Spooner* recommends the plan adopted by Dr. John J. Caldwell, of Baltimore,† to inhale at first twice daily and then once daily, a tablespoonful of a mixture made as follows, diluted with an equal quantity of water: Rx. Extract of belladonna, five to ten minims; bromide of potassium, one scruple; bromide of ammonium, two scruples; water, one ounce. The good effect is said to be shown immediately; the

* Boston Med. and Surg. Jour., Nov. 5th, 1874.

† Ibid. April 20th, 1871.

distressing symptoms being promptly relieved, and the period of the disease much lessened in its course.

Inhalations of a solution of bromine have been recommended in croup. I have witnessed good results from a solution containing one grain of bromine and five grains or more of bromide of potassium to the ounce of water.

Dr. Johann Schnitzler* reports two cases of croup, treated with inhalations of a solution of bromide of potassium; one of which terminated fatally, the other resulting favorably.

First Case.—This was a three-year-old boy, a sister of whom had recently died of croup. The doctor saw the child on the third day of the disease. It was then lying in a state of apathy upon its mother's arms, the countenance pale, the eyelids half closed, the hands hanging by the side. Suddenly the child became uneasy, put its hands up to its throat, and began to cry and to cough, but both cough and voice were toneless; the child could be seen to cry and to cough, but it could hardly be heard to do so. The breathing was difficult, and marked by the peculiar râles of croup; the pulse was small, barely to be counted, and gliding from under the finger. Examining the fauces, large white patches (*plaques*) covered the tonsils and the entire posterior pharyngeal wall. During the examination, the breathing became more difficult, and the child hurriedly but vainly gasped for air. An emetic had no effect. In spite of the unfavorable prognosis, an attempt was made to save the patient, and an inhalation of a solution of bromide of potassium, five grains to the ounce, was instituted. As a large proportion of the fluid struck the pharynx, it detached much of the patches, which was spat out. For two hours the child felt better, but soon the threatening symptoms recurred again, and in spite of five repetitions of the inhalation, the child died that night with symptoms of suffocation.

Second Case.—This was a well-developed child, six months old, with pseudo-membranous croup. Inhalations of bromide of potassium, ten grains to the ounce of water, were administered.

* Wiener medic.-Halle, July, 1862, No. 29.

After fifty to sixty inspirations, instead of the râles, a flapping respiration ensued, as from the air passing and repassing a membrane partially detached. Soon there was so much improvement that the cough was less frequent and the voice less hoarse. This improvement continued four or five hours, when the previous symptoms returned. Another inhalation produced the same relief, which continued throughout the entire night. The following morning the child's appearance was quieter, the pulse had gone down from 130 in the minute to 100, and voice and cough were somewhat hoarser, but the cough no longer so severe. Another inhalation produced again the same effect as before, but to a greater extent; another inhalation was given in the evening, followed by quieter sleep. Pulse in the morning, 96-100; two inhalations during the day. The next morning, the fourth of the treatment, after the child had in all taken six inhalations, two ounces each time, the breathing had become quiet, pulse not accelerated, voice nearly as clear as natural, and the cough almost entirely gone.

CAMPHOR.

Dose.—One grain to the ounce, in emulsion.

Camphor has been used, with mucilage of gum arabic, in the putrid expectoration of phthisis (Fieber); but must be discontinued on the appearance of congestion or irritation. It is sometimes of use in spasmodic coughs.

OIL OF TURPENTINE.

Dose.—One to five drops to the ounce of water.

Oil of turpentine has been used with advantage in the dyspnœa of asthma, and in the chronic catarrh of emphysema (Leiblinger, Waldenburg); in pulmonary phthisis with excessive secretion (Waldenburg); in chronic inflammatory affections of the air-passages generally, especially when attended with offensive secretions, as in putrid bronchorrhœa and gangrene of the lungs.

OILS OF PINE.

Dose.—The same as oil of turpentine.

The oils of pine have been used for the same affections as are treated by oil of turpentine; the oil from the Scotch fir being usually preferred, although the mountain oil, and other oils of pine, are sometimes employed for the same purpose. Lewin has tried oil of pine in alcohol as an exeatant in aphonia, but without material result.

OIL OF CADE.

Dose.—One to two drops to the ouncee of warm water.

The oil of cade has been recommended chiefly in the chronic catarrh of emphysema. (Leiblinger.) It is applicable to the same affections as oil of turpentine and the like.

OIL OF COPAIBA.

Dose.—The same as the above.

Oil of copaiba has been recommended in the same affections as oil of turpentine. (Trousseau.)

OIL OF CUBEB.

Dose.—The same as the above.

Oil of cubeb has likewise been recommended in the same affections as oil of turpentine. (Trousseau.)

CREASOTE.

Creasote.—*Dose.*—An ouncee or so of a solution containing from one to ten drops to sixteen ouncees of water.

Creasote Water.—*Dose.*—One to ten drops to the ouncee of water.

Creasote is applicable to the same diseases as oil of turpentine, and, in addition, to the chronic laryngitis of

phthisis, and to fetid coryza. My friend, Dr. James Collins, of Philadelphia, has seen considerable benefit from the use of creasote water, five drops to the ounce, in the anginose form of scarlatina, even after the failure of other local remedies, such as chlorate of potassium and the like.

CARBOLIC ACID.

Dose.—One to two grains of the crystallized acid to the ounce of water.

Carbolic Acid Water.—*Dose.*—Five to ten drops to the ounce of water.

Carbolic acid is applicable to the same diseases as oil of turpentine and creasote, and is much more extensively employed than either.

It is likewise recommended in diphtheria, fetid sore throat, and fetid coryza. It has been highly recommended in all stages of phthisis. (Wolfe.*). Dr. Labort, of Vincennes, informed Dr. Wolfe that he had administered it to between two hundred and three hundred patients in different stages of phthisis with marked benefit. Fifteen drops of the pure acid were dissolved in two ounces of spirit, and the solution mixed with thirty-two ounces of water; and this amount was administered daily, partly by the stomach, and partly by inhalation in spray.

Shortly after the publication of Dr. Wolfe's article, the inhalation was tried by Dr. J. Forsyth Meigs, of Philadelphia, both in the Pennsylvania Hospital and in private practice; and this gentleman informed me that he had found it of some value as a palliative in phthisis. This opinion is now pretty generally maintained.

* Med. Times and Gaz., Nov. 25th, 1865; Brit. and For. Med.-Chir. Rev., Oct. 1866, p. 538.

I have sometimes used sprays containing a drop or two of the concentrated or deliquescent acid (Calvert's by preference) with from five to ten drops of the compound tincture of iodine to the ounce of water, twice or thrice a day, with considerable benefit, in chronic bronchitis, in the ulcerative laryngitis of phthisis, and in the ordinary purulent stage of the disease.

Dr. William Marcet* reports favorably as to his own success in phthisis with the spray of solutions containing from one grain to a grain and a half of the crystallized acid to the ounce of water, once a day or once in two days, for fifteen or twenty minutes at a time. He does not recommend it in the first acute stage, or in the acute second and third stages. He thinks that a solution containing more than two grains to the ounce should not be used, on account of its depressing action on the cardiac pulsations.

Leyden† has recommended the use of carbolic acid inhalations in pulmonary gangrene, the solution used containing from two to four per cent. of the acid, and the odor or taste masked, for sensitive patients, by peppermint water.

Riegel‡ fully substantiates the exceedingly favorable results recorded by Leyden.

Helper§ has found these inhalations successful in severe cases of true croup.

* The Practitioner, Nov. 1868, p. 265.

† Ueber Lungenbrand. Volkmann's Sammlung klinischer Vorträge.

‡ Ziemssen's Cyclopaedia, vol. iv, New York, 1875.

§ (Deutsche Klinik, 1871, No. 26); Waldenburg, op. cit., p. 40.

TAR.

Infusion of Tar.—*Dose.*—One to four drachms to the ounce of water.

Tar-water is disinfectant, somewhat astringent, and slightly stimulant to the mucous membrane. It is employed in non-febrile conditions of chronic inflammations of the air-passages with excessive secretion. It is useful in the ulcerative laryngitis of tuberculous phthisis, in pulmonary phthisis (Waldenburg), in phthisis with purulent secretion and colliquative sweats (Lewin), in pulmonary gangrene (Waldenburg), in putrid bronchorrhœa without fever (Waldenburg, Lewin), in dilated bronchi with emphysema. (Waldenburg.) Siegle terms it an antiseptic par excellence.

I have witnessed excellent effects from the spray in advanced stages of pulmonary phthisis with free secretion; the expectoration, cough, and dyspnoea becoming less annoying, and the local comfort being materially increased.

LIME.

Solution of Lime.—*Dose.*—One ounce of the officinal solution, diluted, when necessary, with one or more parts of water.

Lime-water is much employed as a detergent, and as a solvent of exudative products. Its chief employment is in croup and diphtheria.

Prof. Biermer,* of Berne, relates the following interesting case of laryngeal croup in the adult, cured by inhalations of warm watery vapor and of lime-water.

* Schweizerische Zeitung für Heilkunde, 1864, p. 157; Lewin, op. cit., p. 287, et al.

A young girl of eighteen years of age, was treated in the beginning of March, 1864, for what appeared to be a simple laryngitis. During breakfast on the morning of March 13th, there suddenly ensued an intense paroxysm of cough, with appearance of asphyxia, cyanosis, cool extremities, loss of consciousness, and complete insensibility. The physician who was called in the emergency, recognized the necessity of immediate resort to some powerful restorative, and applied a hot hammar upon the breast; but without exciting any reaction. Under continued severe irritation of the skin, and the use of liq. ammon. anisati, the patient gradually came to, and eventually coughed up a considerable quantity of croup membrane; after which the respiration became easier. After this attack, the breathing remained stenotic, rattling, and whistling. On her reception into the hospital, the morning of the same day, the countenance was still very livid, the eyes dull, the pulse very feeble and small, the nose and extremities cool, and the crowing respiration was accompanied by paroxysms of cough, during which pseudo-membrane was expectorated. One patch was ring-shaped, having received the impression from one of the rings of the trachea. External irritation, and calomel, succeeded in diminishing the dyspnœa. The next morning, intense dyspnœa again set in, accompanied with the ordinary croupal long-drawn inspiration, with the employment of all the auxiliary muscles, and marked inspiratory incurvation of the serobiculus cordis. In spite of the vomiting induced by an emetic, the orthopnoëtic symptoms increased, with lividity of the countenance and great distress during the continuance of the cough. Under these circumstances, in order to moisten the dry mucous membrane of the air-passages, the inhalation of warm water, broken up by the pulverisateur, was employed. This agreed with the patient so well, that finally boiling water was permitted to be nebulized through the apparatus, for the patient declared that the warmest steam possible afforded her the greatest relief. She inhaled the warm steam for an hour with great eagerness, and expectorated to a considerable extent, while the dryness and difficulty of breathing gradually lessened. Then a stormy suffocative paroxysm of cough came on, during which a considerable quantity of mucus and pieces of croupal membrane were expelled. The patient then breathed much more freely, and felt greatly relieved. From this time on, she inhaled every two hours warm lime-water, in the proportion of one part to thirty, each inhalation continuing a quarter of an hour. From this time

forward, the symptoms of croup declined more and more, and with a profuse expectoration of thick, crumby, yellow, purulent masses ; the fever abated, and convalescence began the following day ; the aphonia, however, continuing until the 9th of April, when it also began to disappear.

M. Biermer and all those who watched the progress of this case, were convinced* that the inhalations had a solvent effect upon the false membrane ; but the Professor does not recommend an exclusive adoption of this local treatment, which softens and detaches the exudations, but does not reach the cause of the disease, which must be combated by constitutional remedies, calomel being considered the chief.

Prof. Biermer was aware of the case of croup reported by Siegle, as cured by inhalations of nebulized water, very warm, and he attributes the happy result chiefly to the high temperature, especially when lime-water is added to it.

Prof. Biermer was led to the employment of lime-water from the statement of M. Küchenmeister,† of Dresden, that diphtheritic membranes are rapidly dissolved in lime-water.‡ This was confirmed by Förster, of Dresden, and also by Prof. Biermer, who repeated Küchenmeister's experiments before the students of his clinical lectures in the University of Berne, placing some pseudo-membranous exudations in a small glass of lime-water ; and they disappeared before the eyes of the

* Brit. and For Med.-Chir. Review, July, 1865, from Bul. gén. de thérap., April 15th, 1865.

† Österr. Ztscher. f. prakt. Heilkunde, 1863, Nos. 13 and 15.

‡ (Dixon, in Duncan's Medical Commentaries, vol. ix, 1783-84, p. 254, recommends lime-water as the best solvent for bronchial casts.) Riegel, in Ziemssen's Cyclopædia, vol. iv; Bibliography of Croupous Bronchitis.

students in from ten to fifteen minutes, leaving only a slight sediment in the bottom of the glass.

Dr. Brauser, of Ratisbon, has also published* the record of a case of croup in a child of four and a half years old, treated in the same manner, a perfect cure resulting. M. Brauser insists on the necessity of using the inhalations hot.

Dr. James Collins, of this city, furnished me with the following record of his experience with inhalations in croup :

Pseudo-membranous Croup.—Mary E—, æt. 11 months. Was called to the case November 18th, 1866. Patient apparently beyond recovery. Lime inhalations employed with little or no effect, and the patient died.

A. B—, æt. 3 years. A robust, healthy child. Had been unwell for a few days, suffering from cough, neglecting its play, and becoming somewhat peevish; but had shown no alarming symptoms until the previous night, when the cough became more brazen and spasmodic. I found the child with marked fever, dyspnœa, husky voice, distressing and spasmodic cough. On examination I found the fauces lined with an albuminous deposit. Lime-water inhalations were at once instituted, and a mustard bath, while one of the family was dispatched for an emetic; but by the time it was procured the symptoms had abated so much that it was not deemed necessary to administer it. The cough loosened, and tough albuminous material was coughed up in large irregular masses, which readily spread out into flakes on being spat into water. The inhalations were continued every two hours that night, and three times the following day, after which I found no other topical application necessary. The inhalations were continued from time to time, a mild purge administered, and turpentine stups applied to the back of the neck and the breast. The child steadily improved and recovered.

Dr. Collins informs me that he has since tried lime-water inhalations in several cases of croup, with success.

* Quoted in Brit. and For. Med.-Chir. Rev., July, 1865.

M. Küchenmeister,* of Dresden, has published a case of diphtheritic pharyngo-laryngitis in a child of three years and a half old, treated with inhalations of lime-water with complete success.

Dr. Da Costa,† of Philadelphia, has watched, in two cases of diphtheria, the action of lime-water on the visible deposits.

In the first case, that of a lady, seen in consultation with her physician on the fifth day of her confinement, the deposit covered the roof of the mouth, the half arches, and part of the wall of the pharynx. There was also,—and indeed the progress of the case placed the matter beyond doubt,—reason to believe that nasal diphtheria existed. She was taking chloride of iron, full nourishment, and stimulants. A stream of pulverized lime-water, about eight times stronger than that officinal in our *Pharmacopœia*,—the saccharated solution of lime of the British *Pharmacopœia*,—was directed upon the affected part by means of an excellent hand-ball atomizer for three or four minutes at a time. The treatment was carried on every few hours, but no perceptible influence on the membrane could be detected. The application was cleansing and very grateful, particularly so when thrown up the nostrils. The case terminated fatally, the membranes in the mouth remaining in a very thick layer.

The second case was that of a gentleman thirty-five years of age. Here there was no nasal diphtheria, nor were the constitutional symptoms by any means so grave; and after the disappearance of the membranes, which took place in about nine days, convalescence was rapid. As local treatment, early in the affection, a strong solution of sulphate of copper was employed. But both at the time, and afterwards, Dr. Da Costa made use of nebulized solutions of lime, in the same manner as in the preceding case, and not hot. The remedy was again very grateful and cleansing; yet, though the same spot in the left half arch was repeatedly selected on which to throw the solution, no perceptible effect in thinning the deposit could be noticed from its influence.

Waldenburg, on the other hand, claims‡ to have often

* *Brit. and For. Med.-Chir. Rev.*, July, 1865.

† *Op. cit.*, p. 32. ‡ *Op. cit.*, p. 416.

seen the pseudo-membrane become smaller and thinner under his eyes, during the inhalation of sprays of lime-water, until it has finally disappeared entirely.

It will be remembered that inhalation of lime-water has been proposed in cases of diphtheria, on account of its supposed solvent powers upon the diphtheritic membrane *in situ*.

The solvent powers of lime-water, even upon pseudo-membrane in a test-tube, is too slow a process to meet the indications promptly, on this principle only, even were they as prompt upon the pseudo-membrane in the living subject. The solvent power *in situ* is very slight, perhaps prevented by the carbonic acid gas meeting it in the throat, larynx, trachea, etc., and converting the lime into its carbonate. The water, the gagging, and the coughing, are perhaps the efficient agents in the undoubted beneficial action of lime-water.

Dr. James Collins, of this city, has furnished me with the following notes of a case of diphtheria, in which lime-water inhalations were administered, under his treatment:

Wm. M——, æt. 3. When called to this little patient, September 24th, 1866, I found him pallid, struggling for breath, with cold extremities, pulse 120 and feeble, and marked diphtheritic deposit lining the fauces and covering the tonsils. According to the mother's statement, the child had been "sickish-like" for ten days, but not sick enough to cause her to send for the doctor. I removed several large flakes of diphtheritic membrane with the finger very readily, gave injections of quinia and beef tea, ordered wine and water, and administered lime-water inhalations. The effect of the local treatment seemed to be quite marked. The difficulty of breathing was greatly relieved; the pulse became less frequent and fuller; the skin became warmer, and for a time the child seemed to be relieved. During the night he again became worse and died.

Dr. H. Ernest Schmid* has published a very instructive case, illustrative of the good result of the persistent administration of inhalations of lime-water in membranous croup.

My own experience with the inhalation of lime-water in croup has been quite limited, from the fact that I find such good results from the inhalation of warm air surcharged with steam, and the inhalation of the vapors from lime in the process of slackening, that I have no temptation to use the spray. I have, however, and that repeatedly, seen distressing symptoms of suffocation relieved by inhalations of lime-water spray, and have also seen copious expectoration of detached and broken-down or imperfect patches of membrane follow their use; sometimes, indeed, tubular casts of the trachea, in one instance which recovered† as many as eight in succession.

Waldenburg reports complete success from lime-water inhalations in a case of chronic croupous bronchitis.

SULPHUROUS ACID.

Dose.—Ten to forty minims, undiluted, or diluted with from one to ten parts of water.

Sulphurous acid has been highly recommended in croup and diphtheria; and likewise in chronic pharyngitis, laryngitis, and bronchitis; in asthma and emphysema; and in phthisis (Dewar).‡

The method recommended by Dewar is to hold the nozzle of the nebulizer (Clarke's handball, or some substitute) about six inches from the patient's mouth, and

* The Medical Record, N. Y., 1867, p. 78.

† Seen in consultation with Dr. James Collins, of Philadelphia.

‡ On the Application of Sulphurous Acid, etc., Edinburgh, 1868.

to administer three or four whiffs of the pure acid (British Pharm.) to begin with; then, after a corresponding interval, during which a cough or two is given, the process is repeated, about twenty squeezes in all, which represents the injection of from forty to sixty minims of acid. The inhalation is repeated hourly as long as required. In some cases of diphtheria it is repeated with advantage as often as every fifteen minutes.

I have employed these inhalations of sulphuric acid with good effects in some cases of diphtheria; and at one time (several years since), when the disease was very prevalent in Philadelphia, kept a stock of the acid constantly in my house, so that I could employ it at the shortest notice. In chronic bronchitis, and allied disorders, I have not found it as efficacious as other treatment.

SULPHURIC ACID.

Diluted Sulphuric Acid.—*Dose.*—One to ten drops to the ounce of water.

Aromatic Sulphuric Acid.—*Dose.*—One to three drops to one to two ounces of water.

The diluted sulphuric acid has been employed with some success in syphilitic laryngitis (Purdon).

LACTIC ACID.

Dose.—Five to sixty drops to the ounce of water.

Lactic acid has been recommended in croup and diphtheria for its solvent powers upon fibrinous exudations. (Brichetau, A. Weber.*)

It is administered in doses of from fifteen to twenty drops in half an ounce of water, every half hour, de-

* Centralblatt. f. med. Wissenschaft, 1869, No. 22.

creasing the proportion of the acid to ten, and then to five drops, and increasing the interval between the inhalations, as improvement takes place.

QUINIA.

Hydrochlorate of Quinia; Sulphate of Quinia—*Dose.*—One-fourth of a grain to two grains to the ounce of water.

Quinia was tried by Fieber in a regularly reurring paroxysmal cough in a consumptive female (two grains of sulphate of quinia, seven drops of tincture of opium, five grains of alum, one ounce of spring water). Haemoptysis ensued on the same day in which it was administered, but whether the result of pulmonary congestion due to the quinia was uncertain. Quinia has likewise been employed by Sales-Girons in tuberculosis. As a matter of course it has been recommended in intermittent fever (Ancelon, Sales-Girons); but it is hardly necessary to intimate that inhalation is not a suitable method of using the remedy in that affection.

Quinia has been recommended in so-called hay-fever (Binz, Helmholz), in the proportion of about one grain to an ounce and a half of water; in whooping-cough (Steffen); and in pueumonia, a one-half per cent. solution of the hydrochlorate of quinia. (Gerhardt.*)

OPIUM.

Extract of Opium.—Dose.—One-fourth of a grain to a grain to the ounce of water.

Sedative Solution of Opium (Battley's).—Dose.—Two to twenty drops to the ounce of water.

* Deutsche Zeitschrift f. pract. Med.; La Tribune médicale, 1874, No. 306; New York Med. Jour., Sept. 1874, p. 321.

Tincture of Opium.—*Dose.*—Two to twenty drops to the ounce of water.

Camphorated Tincture of Opium.—*Dose.*—Half a drachm to four drachms to the ounce of water.

Acetate, Muriate, and Sulphate of Morphia.—*Dose.*—One-forty-eighth to one-eighth of a grain to the ounce of water.

The preparations of opium are exceedingly useful as sedatives and narcotics in painful inflammatory affections of the throat and air-passages, whether simple catarrhal, tuberculous, serofulous, syphilitic, or cancerous. They are sometimes employed in whooping-cough and in asthma. They are also serviceable in irritative and spasmodic coughs, even the spasmodic cough of hysteria. They are frequently added to other solutions to relieve pain at the same time that the effort is made to combat morbid processes or ameliorate their manifestations. A favorite remedy with myself in the painful ulcerative laryngitis attending tuberculosis or disease of the cartilages of the larynx, is the camphorated tincture of opium, a drop of the essence of peppermint being added to each ounce of the solution.

In the follicular inflammation of the pharynx and larynx of public speakers and singers, I have seen good results follow the inhalation of a weak solution of opium, or some other narcotic, at a somewhat elevated temperature, just before employment of the voice.

The same may be said of the use of these sprays, just before eating, in the painful dysphagia of the chronic laryngitis of phthisis.

They are sometimes remarkably useful, too, in acute affections.

Thus, in a severe case of tonsillitis in a lady of this city who is

subject to attacks of ulcerative tonsillitis, and several members of whose family I was attending during an epidemic of influenza some years ago, I succeeded in aborting the disease by strong inhalations of opium, employing a solution of five grains of the watery extract to the ounce of distilled water, and repeating half the quantity at intervals of two hours. The relief to the pain, difficulty of breathing, etc., was very prompt, narcotism soon ensued, and after a sound sleep deglutition was again practicable, and inhalations of warm water simply were substituted for the opiate inhalations, of which she had taken but three, containing ten grains of the extract of opium; but it must be remembered in connection, that the patient was in bed, took the inhalations from the side, and the probability is that not more than three grains at the utmost gained access to the parts, some of it being diffused in the air, and a good deal that entered the mouth being expelled again in expiration.

In ordinary acute sore throat, I have often seen great advantage follow the use of the extract of opium in doses of a grain or less to the ounce.

I have casually treated two cases of œdema of the larynx with opium.

A lady in this city was carried out insensible from the upper story of a house on fire, in which very combustible materials, as soaps, oils, etc., were burning. The dense hot smoke from these substances had been inhaled, and had produced an intense laryngitis with complete aphonia. I was called to the patient a few hours after the occurrence, and found her exhausted, in great distress from dyspnœa, and threatend with death from suffocation. A solution of the watery extract of opium was immediately procured, and an ounce administered warm by inhalation, with relief to the suffering, and, to some extent, to the dyspnoetic paroxysms. The inhalations were repeated every half hour, for four or five times, until respiration had become markedly relieved, when they were given in a more diluted form every two hours. I paid the patient five visits within seven hours, and at each visit administered the inhalations myself, so as to insure the proper administration of some of them. The expressions of gratitude for relief were such as to leave no doubt as to their good result, and the patient would not have parted with the apparatus under any consideration. The

opium inhalations were continued three or four times a day for a week, when the acute symptoms of laryngitis having subsided, tannin was substituted, with the result of return of voice.

Another lady in this city was sent to me by my friend and collaborer, Dr. D. D. Richardson. The laryngitis in this instance was very painful, and complete aphonia had existed for five days. There was very great dyspnœa, so that the patient gasped for breath as she entered my consulting-room. She said that, several times, while on her way to visit me, she felt as though she would not be able to breathe any longer. A laryngoscopic examination revealed the aryteno-epiglottic folds very much swollen and inflamed, and the so-called false vocal cords so œdematosus, as to entirely cut off a view of the true cords. This appearance was recognized by Dr. Henry V. Gray, of Petersburg, Va., who happened to be in my office at the moment, a gentleman who was, at that time, himself familiar to some extent with the use of the laryngoscope. In order to relieve the intense distress of the patient, I placed her before an apparatus from which a patient, but a few minutes before, had been inhaling a warm solution containing a drachm of laudanum to the ounce of water; and set the pump going, while I was getting out my scarificator, with the intention of scarifying the swollen structures. She could not have taken above half a dozen inspirations, when she heaved a long sigh of relief, followed by a prolonged oh! and, continuing the inhalation, in a few minutes the dyspnœa had vanished, and the voice had returned, rendering scarification unnecessary; for on a second laryngoscopic examination, the tumefaction was so much reduced as to forbid surgical interference. The result was unanticipated by myself, and Dr. Gray exclaimed, "Why, Doctor, that is magic!"

A dose of sulphate of magnesia was ordered for the patient, and she was directed to use embrocations of the oil of turpentine externally for a few days. The trouble rapidly subsided after the single inhalation, so that its repetition was not requisite.

It is my desire not to be misunderstood as recommending dependence upon sprays in the treatment of so formidable a condition as œdema of the larynx. The knife offers the proper means of relief, if the extent of the œdema is at all alarming, or even stationary and likely to become serious.

Fieber reports* a case of laryngo-tracheal catarrh, with almost complete aphonia, in which the voice soon returned under the inhalation of a solution containing six drops of laudanum, and six grains of sulphate of zinc to the ounce of water.

Fieber reports† in detail a remarkable case of inferred phthisis, treated mainly by opium :

A married woman, æt. 38, was troubled with exacerbating paroxysms of cough and vomiting, every night about three o'clock A.M. Her general condition was improved by tonics,—bark and quinine,—but without any impression upon the severity of the cough, or the amount of the sputa. Narcotics and demulcents were of no avail. Then, abandoning all remedies except the tincture of cinchona, Fieber instituted inhalations with the pulverisateur. Within twenty days the patient took, in all, 3635 inhalations (*inspirations*) ; the smallest number in any one day being 40 ; the largest, 300 ; the average, 240. This treatment began September 12th, 1861, with 40 inhalations of the spray of pure water. September 14th, 80 inhalations, consuming five minutes, of a solution of laudanum, three drops to the ounce of distilled water. The soothing effect being trifling, he increased the proportion to five drops, and on the 16th she took 80 inhalations, and the soothing effect was greater ; 17th, 100 inhalations in five minutes ; 18th, 5 grains of alum was added to prevent too great a degree of somnolence, which showed itself particularly towards evening ; and of this, 75 inhalations in four and one-half minutes ; 19th, 160 inhalations in ten minutes ; 20th, 21st, 22d, each day 240 inhalations in fifteen minutes. Now she coughed very little during the day, and the expectoration had decreased. The nightly paroxysms of cough had lost nothing of their intensity. He then determined to make an experiment with an antiperiodic mixture, and on the 23d the patient took 200 inspirations of a fluid containing to the ounce of water two grains of the sulphate of quinia (of which 0.64 grs. dissolved, the rest remaining suspended), seven drops of tincture of opium, and five grains of alum. Nothing peculiar was noticed during the inhalation, but haemoptysis occurred on that day, and also on the succeeding day, in all together to the amount

* Op. cit., p. 119.

† Lewin, op. cit., p. 244.

of about four teaspoonfuls of blood, alkaline in reaction; and there was increase of the catarrhal symptoms. The patient complained of the numbing sensation produced by the alum, and of its taste; and on the following day, September 25th, she took 120 inhalations, in seven and one-half minutes, of a mixture of five drops of the tincture of opium, seven and a half grains of tannin, and one ounce of water. This solution was retained to the end of the treatment. The catarrh decreased; the sputa showed less blood. September 26th, no blood in sputa; catarrh trifling. The nightly paroxysm, suspended for an hour, appeared at four A.M., and was less intense than heretofore. Patient complaining of weariness, no inhalation; 27th, 240 inhalations in fifteen minutes, paroxysm again at four A.M.; 28th and 29th, same treatment, paroxysm came on at five A.M., and for the first time so modified that the patient did not vomit towards the last of it, as had been the case since June; on the 29th, the patient thought that she had overslept her paroxysm, but it came on, however, at six A.M.; 30th, no inhalation; the paroxysm came on at seven A.M., and was still weaker. October 1st, no paroxysm; 240 inhalations. Patient can now inhale without producing the least disposition to cough, as had always been the case, more or less, until this day. She has been sleepier than usual for several days, owing to the effect of the opium inhaled. October 2d, 250 inhalations; 3d, no inhalations; 4th, 5th, and 6th, each day 240 inhalations. At this point the treatment was discontinued, as there had been no paroxysm for several days, but little cough, and very trifling secretion. The percussion was the same as at the beginning of the treatment; but of the catarrhal râles, there remained only some rude respiration on the left side.

The following case is from the same source:

Tuberculosis of left lung, hæmoptysis, intense cough, marked improvement under inhalations of opium and alum. Patient, a man æt. 28, feeble, emaciated, tuberculous infiltration of left upper lobe, cough intense and painful, expectoration easy but very profuse, pulse 120. Treatment began May 10th, with inhalations of two drachms of the tincture of opium to two pounds of distilled water, 20 inhalations in the morning and 10 in the evening, increased by the third day to 30 in the morning and 20 in the evening, with decrease in the frequency of the cough and in its intensity, decrease of moist râles, and reduction of pulse to 108.

Now, two drachms of alum were added to the opiate solution ; expectoration decreased, strength increased. June 17th, 40 inhalations in the morning, 30 in the evening. July 1st, 50 inhalations morning, 40 evening. July 2d, 50 inhalations morning and evening. Three grains of quinine were now added daily. Then the strength of the patient increased in a marked degree. After several nightly excesses, on July 9th a slight haemoptysis, not followed by any injurious results. Early in August the catarrh was reduced to a minimum, and the patient returned to his own residence.

In the distressing cough of chronic bronchitis, especially when accompanied by excessive pain, an inhalation of tepid or warm water, containing from ten to twenty-five per cent. of paregoric, or an equivalent quantity of extract of opium, or the like, will often prove grateful and efficacious. I have had excellent results from the paregoric in this way, especially when taken at short intervals (one to two hours), a few hours before the usual time of composure for sleep.

Dr. Ludwig Joseph, of Breslau,* has employed a solution of acetate of morphia in bitter almond water and fennel-seed water, as recommended by Fieber and others, with good results in painful affections of the air-passages.

HYOSCYAMUS.

Extract of Hyoscyamus.—*Dose.*—One-fourth of a grain to two grains to the ounce of water.

Fluid Extract of Hyoscyamus.—*Dose.*—Three to ten drops to the ounce of water.

Tincture of Hyoscyamus.—*Dose.*—Two to ten drops to the ounce of water.

Hyoscyamus is employed in the irritative coughs of

* Deutsche Klinik, May 26th, 1866.

catarrhal inflammations, and in spasmodic coughs generally. It has been used by Fieber in whooping-cough, in severe bronchitis, and in bronchial catarrh attended with spasm; and by Leiblinger and Lewin in phthisis. It has also been employed in the cough and dyspnoea occurring in the intervals between the paroxysms of asthma (Waldenburg).

Fieber reports* the case of a child four years of age, in whom the paroxysms threatened suffocation, and in which, the disproportion between the objective symptoms and the subjective phenomena leading him to consider the affection a disease of the par vagum, rather than of the minute bronchi and air-cells, he resolved to employ inhalations of the following mixture: Aleoholic extract of the seeds of hyoscyamus, six grains; olive oil, one fluid ounce; pulverized gum arabie, half an ounce; spring water, two pounds. After eight days' use, the disease had become so mild that further attendance was unnecessary. The emulsion was very well nebulized. Treatment began April 23d, 380 inhalations (*inspirations*) readily taken; no cough, narcotic effect produced. 24th, same treatment; four spells at night, no blood in sputa; next night two paroxysms of cough. The cough worse in daytime while the child is moving about. 25th, 380 inhalations. 26th, one spell during the night, less intense than before; 380 inhalations. 27th, child slept all night, 380 inhalations. This treatment was kept up until the 30th, with cessation of all the disagreeable sensations.

As far as the palliative treatment of chronic phthisis by sprays is concerned, I have chiefly employed hyoscyamus and infusion of wild cherry, with an occasional astringent when the expectoration was profuse and exhausting; and tar-water as an antiseptic. The inhalation of warm water alone will facilitate expectoration. Nearly all of my cases have experienced great relief from the topical effect of the inhalations.

In one case, that of a medical friend and former schoolmate,

* Op. cit., p. 116.

the relief to the dyspnœa from these inhalations was far greater than had been procured by any other method. This gentleman preferred the tincture of hyoscyamus, ten drops to the ounce of water, or of infusion of wild cherry bark; and he often told me that the inhalation of half this quantity was sufficient to place him perceptibly under the narcotic influence of the hyoscyamus.

CANNABIS INDICUM.

Extract of Cannabis Indicum.—*Dose.*—One-fourth of a grain to a grain to the ounce of water.

Tincture of Cannabis Indicum.—*Dose.*—Five to ten drops to the ounce of water.

Indian hemp is sometimes employed in irritative coughs and spasmodic coughs, and Leiblinger has recommended the extract in the spasmodic cough of phthisis.

CONIUM.

Extract of Conium.—*Dose.*—One to six grains to the ounce of water.

Fluid Extract of Conium.—*Dose.*—Three to eight drops to the ounce of water.

Tincture of Conium.—*Dose.*—One to five drops to the ounce of water.

Conium is recommended in very painful irritations of the larynx (Lewin), in hyperesthesia of the larynx (Waldenburg), and in asthma (Da Costa). I have found it useful in irritative coughs, and in the painful dysphagia attendant upon the chronic laryngitis of phthisis.

BELLADONNA.

Extract of Belladonna.—*Dose.*—One-fourth of a grain to one or two grains to the ounce of water.

Tincture of Belladonna.—*Dose.*—One to ten drops to the ounce of water.

Sulphate of Atropia.—*Dose.*—One-fortieth of a grain to the ounce of water.

Belladonna has been recommended in the nightly irritative coughs of children (Sales-Girons, Blache), in spasmodic coughs, chiefly hysterical (Waldenburg), and in the dyspnoea of emphysema, associated with severe cough (Waldenburg). The sulphate of atropia recommended by some authors, is justly pronounced by Fieber as unnecessary and dangerous.

STRAMONIUM.

Extract of Stramonium.—*Dose.*—One-fourth of a grain to a grain to the ounce of water.

Tincture of Stramonium.—*Dose.*—One to ten drops to the ounce of water.

Stramonium is sometimes used for the same purposes as other narcotics (Lewin), but has also been much used by some practitioners in asthma. Waldenburg has found it of service in the dyspnoea of emphysema.

DIGITALIS.

Extract of Digitalis.—*Dose.*—One-fourth of a grain to a grain to the ounce of water.

Tincture of Digitalis.—*Dose.*—One to ten drops to the ounce of water.

Digitalis is sometimes employed for the same purposes as other sedatives (Lewin). It has likewise been recommended in tuberculosis, especially in the febrile condition (Gerhardt).

HYDROCYANIC ACID.

Dilute Hydrocyanic Acid.—*Dose.*—One drop to one or two ounces of water.

Bitter Almond Water.—*Dose.*—From a few drops to the ounce, to the full strength.

Cherry Laurel Water.—*Dose.*—From a few drops to the ounce, to the full strength.

Infusion of Wild-Cherry Bark.—*Dose.*—One or two ounces.

The dilute hydrocyanic acid itself is rarely employed by inhalation. It has been recommended as a sedative (Fieber); but it requires care in its use, and it is better to resort to the other preparations mentioned, which contain the acid in smaller proportion.

The bitter almond water is recommended by Lewin as a good menstruum for chloride of iron and other irritating remedies. Both this water and the cherry laurel water have been recommended by Siegle in excessive paroxysmal cough, especially that accompanying acute laryngitis and the laryngitis of phthisis, and likewise as a sedative in painful affections of the respiratory tract in general.

I have used the infusion of wild-cherry bark with good results in the chronic laryngitis of phthisis, and in chronic, nervous, or habitual coughs of frequent occurrence, but unattended with appreciable structural lesion.

LOBELIA.

Tincture of Lobelia.—*Dose.*—Two to ten drops to the ounce of water.

Lobelia has been recommended in asthma, and in the same diseases in which sedatives generally are employed (Lewin).

IPECACUANHA.

Wine of Ipecacuanha.—*Dose.*—Ten to sixty drops to the ounce of water, or five to thirty minims undiluted.

Inhalation of the spray of wine of ipecaenanha, pure or variously diluted, has been found of great service by Drs. Ringer and Murrell,* in winter cough and bronchitic asthma. When the undiluted wine is used, the patient is instructed to expectorate the residue that remains in the mouth, in order to avoid the nausea which may ensue from swallowing it. At first but a few (two or three to twenty) squeezes of the hand-ball nebulizer can be borne by the patient; but the tolerance usually soon increases. The inhalation is at first employed once a day, or two or three times a day in bad cases, the intervals being increased gradually as improvement takes place.

ASSAFOETIDA MIXTURE.

Assafetida mixture, in combination with peppermint water and castor water, has been used by Lewin, in asthma with emphysema.

SUMMARY.

In reviewing the entire subject, as portrayed in the preceding pages, we may conclude that the employment of remedies in this form is by no means to be ignored or underestimated, as far, at least, as regards diseases of the respiratory passages; that these inhalations are not to be used carelessly, for the reduction of tension in the air inhaled while loaded with nebula may induce congestion, which may prove detrimental, as in the case related by Fieber, in which haemoptysis was induced, and in the case related by Troussseau, in which fatal pneumonia was induced by the too frequent inhalation of an astringent, and as shown in the experiments of Demarquay

* *The Lancet*, Sept. 5th, 1874, p. 338.

upon rabbits, in whom the inhalations produced pleuro-pneumonia; that there is indubitable evidence of their great value in certain forms of sore throat, and particularly so in children; that they can be resorted to with confidence to restrain hæmorrhage, to subdue irritation and inflammations, to relieve dyspnoea, to repress excessive secretion, to resolve exudation,—in fact, to do all for the respiratory mucous membrane that can be accomplished for other structures by the application of moisture, simple and medicated; that under favorable conditions of system, apart from constitutional implication, they are directly adequate to the cure of chronic affections of the respiratory organs that are at all curable; perhaps, in part, by inducing exercise of the parts as an essential element of the process, and thereby exciting restorative nutrition leading to resumption of normal function; but that they are not, in themselves and by themselves, adequate to the cure of disease, independent of general treatment; that they are less applicable to acute affections than to chronic, except in so far as they palliate special symptoms or relieve them; that they are less efficient than local applications by the mop or sponge, in cases of thickening, or ulceration, or other evident change of structure in parts within reach of the probang; and that, therefore, though not specific in the usual sense of the term, they are to be regarded as an invaluable addition to our approved methods of administering remedial agents, and as such entitled to our favorable consideration.

After an additional experience extending over ten years, I find no reason to alter the opinion expressed in the above summary, as it appeared in the first edition of this volume.

PART III.

THE INHALATION OF POWDERS.

THE INSUFFLATION OR INHALATION OF POWDERS IN
AFFECTIONS OF THE RESPIRATORY ORGANS.

THE earliest employment of powders by insufflation, in the treatment of diseases of the air-passages, is ascribed to *Aesculapius*, who, according to Galen,* was accustomed, in cases of angina, to blow an astringent powder into the larynx by means of a bent reed; a method considered something of a novelty, even at the present day. The remedies employed in this manner are said to have been chiefly nutgall and myrrh.

Arctaeus, of Cappadocia, is said to have used a similar instrument in the latter part of the first century, and for the same purpose, especially in the laryngeal complaints of children. Darwin† constructed a box, in which powders were stirred up for inhalation by turning a cylinder of bristles, the mouthpiece for inhalation being at the top of the box, a second opening being provided below for the passage of the atmospheric air;‡ while in more recent times the former method was reintroduced into practice by Bretonneau, Troussseau,§ and Belloc, followed by many others, who have devised in-

* *De compositione medicamentorum localicium, etc., lib. vii,*
Cap. 3.

† Beddoes, op. cit., p. 143. ‡ Waldenburg, op. cit., p. 305.

§ *Traité pratique de la phthisie laryngée*, Paris, 1837, p. 349;
Traité de thérapeutique et de matière médicale, Paris, 1841.

struments of various form and mechanism for the propulsion of the powders. Quills, hollow reeds, and tubes of glass, metal, or hard rubber, are used for the purpose. Trousseau's instrument consists of a glass tube of convenient size, within one aperture of which is to be inserted from three to four grains of the powder to be used; the other end is placed as far as possible within the mouth of the patient, who closes his lips upon it and takes a forced inspiration through the tube. Trousseau recommends the medicinal powders to be rubbed up with sugar of milk, to give them sufficient body. His formulæ are, for bismuth, 1 part to 1, 2, or more of the sugar of milk; for alum, 1 part to 2; for acetate of lead, 1 to 7; for calomel, 1 to 12; for red precipitate, sulphate of zinc, and sulphate of copper, 1 to 36; for nitrate of silver, 1 to 24-72. He employed the alum and bismuth in relaxed conditions of the mucous membrane, unattended with marked inflammation; the salts of lead and copper, in cases of considerable inflammation; nitrate of silver, in cases of known or inferred ulceration; the mercurial preparations, in syphilitic cases, and also in non-specific ulcerations. The insufflations were made daily, or every other day, three or more grains of the powder being used at a time.

Prof. Burow,* of Königsburg, was in the habit of employing in this manner nitrate of silver, three grains to the drachm of sugar of milk, in chronic laryngitis. He reported a number of cases of several years' standing, with almost complete aphonia, which were cured in a few weeks, with restoration of the voice even to purposes of vocal music. Finding with many of his pa-

* Deutsche Klinik, 1853, No. 21.

tients an inability to inhale the powder by the methods previously recommended, and that in some cases the powder was actually blown out of the tube in expiration, he devised a special contrivance, composed of two parallel tubes, one furnished with a valve, so that the powder could not be blown out by expiration, but was compulsorily inhaled in inspiration. The quantity of the powder employed by him was as much as could be put in the nib of an ordinary steel pen ; and this amount was used daily.

Pserhofer,* of Vienna, used a box similar to that of Darwin, and he not only treated laryngeal, bronchial, and pulmonary troubles by inhalations of powders, but also employed the respiratory tract for the introduction of medicines in the treatment of affections of other organs.

Ebert,† of Berlin, employing the same mixture as Burow, three grains of nitrate of silver with a drachm of sugar of milk, placed the powder in a steel pen, which he inserted half way within a quill open at both ends. The quill was introduced within the mouth in such manner that the nib should lie over the root of the tongue, when the patient, closing his lips over the quill, and compressing his nostrils, inhaled suddenly and strongly. He found the patients' first attempt usually unsuccessful, the powder only getting upon the base of the tongue and about the pharynx, so that when nitrate of silver was used, the peculiar metallic taste was per-

* Schmidt's Jahrb., 1856, xcii, p. 170.

† Die Behandlung der Laryngitis mit Einathmungen von Argenticum Nitricum in Pulverform, Annalen der Charité Krankenhauses, vol. i, 1854, p. 93; Am. Jour. Med. Sci., Oct. 1855, p. 515.

ceived in these parts; but generally after the second or third attempt the powder was more or less thoroughly inhaled, as evinced by spasm of cough, burning sensation in the larynx, etc. Twelve cases of laryngitis are narrated, some in young and delicate females, in which satisfactory beneficial results followed this treatment. These details are reproduced by Lewin.*

Lewin, of Berlin, uses a small tubulated retort for the inhalation of powders, a small tube passing through the stopper to the bottom of the retort in which the powder is placed, the patient inspiring forcibly through the beak of the apparatus.

The glass tubes of Troussseau were straight, and therefore better adapted for treating affections of the palate and pharynx, than those of the larynx and trachea. They have been modified by bending the terminal extremity so that it can be placed behind the epiglottis, or over the entrance into the larynx. Since the use of the laryngoscope as an aid in making topical applications to the upper air-passages, these tubes have been made with flutelike extremities, the opening at the side presenting in any desired direction, so as to facilitate the propulsion of the powder upon circumscribed portions of the upper portion of the larynx. This refinement is hardly necessary, as the ordinary bent tube can be readily held in the proper position when it is requisite to limit the application in the manner indicated. Some practitioners still employ the method introduced by Stoerck, of Vienna, which is to attach rubber tubing to the proximate extremity of the insufflator, the free end of which is furnished with a mouthpiece which is placed in the mouth

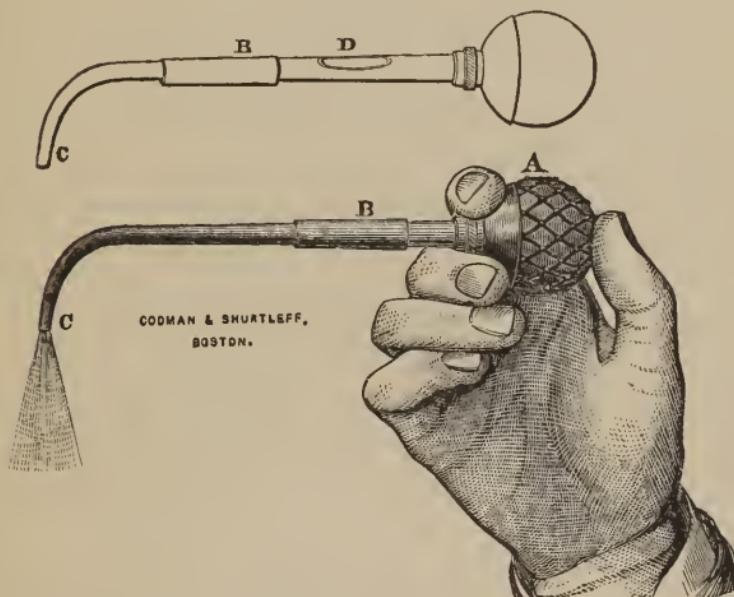
* Op. cit., pp. 126 to 136.

of the operator, who then blows the powder into the throat of the patient. This method moistens the insufflator, to which the powder sometimes sticks, so as to prevent its propulsion through the tube, and renders it extremely liable to become clogged. Then the powder is sometimes forced back into the mouth of the operator during an expiration by the patient. To remedy these inconveniences, Czermak attached a rubber ball compressor to the flexible tubing, which is compressed at the proper moment. These latter methods are methods of insufflation, and not inhalation or aspiration. The movement of propelling the powder is a single movement, made during a normal or voluntary inspiration, or a voluntary pause in respiration. The patient, in some instances, can use the instrument with the compressor himself; but in general the application is made by the physician, or by an attendant who has been instructed in the manipulation. The patient should restrain the disposition to cough as long as practicable, so as to secure the retention of the powder, otherwise most of it will be expelled. The insufflation may be repeated several times in succession, with short intervals of rest, and be renewed once or twice a day.

The most convenient insufflator that I know of is that of Gilewski and Rauchfuss (Fig. 28), which consists of a properly shaped tube, with a gum ball for the purpose of propelling the powder forwards. The powder is inserted into a slot in the tube, over which a tubular cover slides after the introduction of the medicine, which can be propelled in any direction desired by arranging the apertures of exit at the distal extremity of the tube. The bulb was devised by Rauchfuss, who originally employed it as a reservoir also, and the slot by Gilew-

ski. Various modifications of Rauchfuss's insufflator have been made, but they possess no advantage, at least in my own hands, over the original instrument.

FIG. 28.



Rauchfuss's Insufflator.

A, compressing bulb ; B, slot covering D, aperture into which the powder is inserted ; C, shower of powder leaving the instrument.

Mandl, Chambers, Fournié, and many others, have devised instruments for the same purpose. Millot* and Gelles† have devised insufflators attached to tongue depressors.

Dr. T. K. Chambers,‡ of London, recommends the inhalation of a light innocuous powder, with which the required medicinal agent may be mingled. He found

* Séance de l'Académie de médecine, Nov. 20th, 1867 ; Mandl, op. cit., p. 548.

† Gaz. hebd., 1869, No. 10, p. 153, illustrated.

‡ Lancet, 1848.

most suited to his purpose the pollen of the lycopodium (club-moss), first allowed to imbibe as much as it would take up of a saturated solution of the substance to be employed (in the cases narrated, nitrate of silver and sulphate of copper, or a combination of the two), and then carefully dried, and afterwards reduced to an impalpable powder. The plan recommended for the inhalation is, that the patient should introduce into his mouth, as far as may be without choking, the tube of a well-dried glass funnel, and draw in his breath strongly at the same moment that an attendant, or himself if able, dusts the powder into the funnel from a nursery puff-ball. To obviate the necessity for withdrawing the funnel during expiration, and to prevent the powder from floating about the room, an apparatus with a double valve, and a closed powder-box, allowing the powder to pass only from without inwards, may be employed instead of the funnel.

Prof. Dickson* thinks he has seen inhalation of the finely levigated powders of cinchona, and the acetate of lead, useful in restraining profuse expectoration.

Prof. R. H. Thomas,† of Baltimore, recommends to the notice of the profession the following simple and easy method of applying nitrate of silver to the air-passages, contrived and adopted by his brother, Dr. John Chew Thomas, of Baltimore.

"Let a fine grindstone or emery-wheel be caused to revolve with great velocity, while a stick of the caustic is lightly held in contact with it. The effect will be to convert the caustic into an impalpable powder, which

* Elements of Medicine, 1855, p. 624.

† Transactions of the American Medical Association, 1855, vol. viii, p. 591, with cut.

may be inhaled freely by the patient, who sits before the stone at a convenient distance; from three to six or eight inhalations may be taken at a sitting, according to the effects, but it is recommended to desist after much cough is created, and the operation may be repeated every two or three days, according to the influence it exerts on the disease."

It has been found, in Dr. Thomas's experience, to be well adapted to chronic inflammation of the larynx, trachea, and bronchi, rarely causing any more than a temporary irritation. He has also used it with good effect in recent hoarseness and slight inflammation of the palate and throat. In established acute inflammation, depletion and general treatment should precede its employment.

Dr. Thomas refers to a number of instances of slight but persistent affections of the larynx and trachea, which were accompanied with weakness of voice, hoarseness, inability to speak or read for any length of time, which were entirely cured by the use of this means; also cases of chronic bronchitis, which had proved very obstinate, yielding perfectly to the steady use of the same agency. He does not claim that it can supersede the use of the sponge and caustic solution, but that in many of the slighter affections of the throat, it may enable us to dispense with the disagreeable necessity of using the mop, and that it is applicable to some cases to which the former method is not.

Prof. Charles Matthews* describes and depicts an instrument of his invention, intended to facilitate the inhalation of the smoke of powders in a state of ignition.

* Am. Med. Times, November 24th, 1860, p. 365.

It consists of two tubes of paper, to the outer of which is attached the mouthpiece, the powder being confined within the inner tube, upon lighting which the smoke is conveyed to the mouth through the interspace between the two tubes. Cubebs is preferred as the vehicle to give sufficient volume to the powder when employed in this manner, for cases where a gentle stimulus is desired; though decayed wood, pine bark, etc., may be employed for the purpose.

An important point to be determined, says Lewin,* in this connection, is whether the powder inspired remains in the respiratory tract, and is not again extruded by the waving outwards of the ciliary epithelium. That this latter occurrence is generally the case, continues Lewin, we know very well. A large quantity of minute dust is continually floating in the atmosphere, especially in crowded cities. Now, if all this were inhaled, and retained in the pulmonary organs, it would eventually produce fatal consequences, because the bronchial tubes would become more or less clogged up. Such a result, however, is avoided by our natural instinct of breathing through the nostrils. The hairs at the external orifices of the nostrils, and the projecting turbinated bones catch the particles of dust inhaled through the nostrils; and these particles are subsequently ejected from time to time by a very familiar process. But after a certain number of nasal inspirations, we find it necessary to gape or take a deeper inspiration than ordinary, for which purpose the mouth is more or less widely opened; usually it is not very widely opened, and the soft palate not being raised very much, the dust taken in with the inspi-

* Op. cit., p. 122.

ration strikes the velum, and becoming entangled in its mucus, it is thrown upon the moist mucous membrane of the tongue, half arches, and pharynx; the dust that has proceeded farther, is arrested by the epiglottis, the ary-epiglottic folds, and the ventricular bands or false vocal cords. If, notwithstanding these hindrances, some of the dust reaches the larynx or trachea, it is detained by the moist mucous membrane, and is expectorated by hawking or coughing, or is gradually removed by the waving of the cilia.

This is much less the case, and in some instances not at all the case, when the materials inhaled are soluble, and dissolve in the bronchial mucus before the cilia can expel them; or when the matters are specifically too heavy to be moved by them; or when too great a quantity has been inhaled; or when the mucous membrane does not possess its full strength and capabilities.

On these grounds, concludes Lewin, it would appear that the inhalation of powders can be employed for the purposes of local therapeutics.

EXPERIMENTS ON MEN AND ANIMALS, PROVING THE PENETRATION OF POWDERS INTO THE RESPIRATORY TRACTS.

Any one can convince himself that powders can be voluntarily drawn at least into the upper air-passages, by directing the dust of some colored substance, as charcoal, for instance, across his mouth, and suddenly taking a deep inspiration. The irritation produced, and the spasms of cough accompanying it, will be proof positive that some of the suspended particles have been drawn beyond the glottis, while an examination with the laryngoscope will show that some particles of the dust have

lodged upon the vocal cords, true and false, the greater proportion being spread on the anterior wall of the trachea, and very little reaching the posterior walls of the larynx. A large portion of the powder will, of course, have remained in the mouth, principally detained about the base of the tongue, and upon the soft palate just above the attachment of the uvula.

A great many experiments have been made upon animals who were forced to inhale powders, and in whom, after section, the presence of the powders has been demonstrated in the respiratory organs.

The principal experimenter in this direction has been Fournié, and his reports have excited a good deal of attention among those interested in the question.

"Dr. Edouard Fournié* has clearly ascertained that the dust of charcoal, flint, starch, etc., penetrates into the bronchi, and he has endeavored to render the fact available in the treatment of disease. In order to obviate any disagreeable sensation on the part of the patient, he recommends the medicinal powder to be breathed in a special contrivance which he describes. It consists of an oval wooden box, fitted with two tubes, so arranged that the patient breathes the air in the box mingled with the medicinal powder. Laryngoscopic examination, and the black expectoration after the use of the apparatus, when charcoal dust has been employed, proves that the dust has entered the respiratory passages. The same apparatus is available for the inspiration of volatilized iodine, and Dr. Fournié has also thus employed for medicinal purposes, starch, alum, tannin, subacetate of lead, and nitrate of silver. The diseases

* Union médicale, February 5th, 1863.

which he has successfully treated have been cases of catarrh, bronchitis, and some of well-marked phthisis."*

Fournié inclosed the head of a coal-heaver, whose nostrils were first compressed by forceps (*pince-nez*), in a sack filled with a quantity of coal-dust, and then the sack was shaken over his head with a good deal of force. The man coughed and coughed, and seemed to feel very uncomfortable. After being allowed to breathe this atmosphere for three minutes, the sack was removed and an examination by the laryngoscope gave the following result: The tongue, soft palate, tonsils, and pharynx, were fully covered with a thick layer of coal-dust; the epiglottis, aryteno-epiglottic ligaments, and the arytenoid cartilages, were marked with coal streaks at several places, and were very much reddened; there was only a thin black streak over the right vocal cord. An examination with the laryngoscope before the experiment, had shown the parts to be normal. This cleanliness of the mucous membrane of the larynx contrasted very strongly with the condition of the trachea, the mucous membrane of which, particularly on its posterior wall, was almost entirely covered with coal-dust. This experiment was repeated by Fournié upon himself and others, with similar results.†

Dr. Moritz Rosenthal,‡ of Vienna, published the records of a series of experiments which he instituted upon rabbits, to determine the extent to which pulverulent substances could be made to penetrate into the

* British and Foreign Medico-Chirurgical Review, July, 1863, p. 241.

† Lewin, op. cit., p. 121.

‡ Schmidt's Jahrbücher, November, 1866, from Wien. Zeitschrift, 1866, No. 1.

respiratory organs. Some very finely pulverized charcoal, sifted through a cloth, was placed in a double linen bag, in which a moderately sized rabbit was confined. The bag, with its contents, was then whirled round for from fifteen to twenty minutes, after which the animal was killed by section of the spinal cord, and the respiratory tract examined from below upwards, to avoid the conveyance by the shears of any of the material from above downwards. The coal was found in the ventricles of the larynx, on the walls of the trachea, and on those of the larger bronchi. By the aid of a lens, it was detected in the interstitial lung-tissue, where it became still more evident upon microscopical examination. Sufficient reasons are adduced to prove that the appearances were not due to the pigment matter normally found in the lung-tissue of such animals. An animal which had been permitted to live for several days after having been similarly exposed to an atmosphere loaded with the charcoal-dust, was examined, but not a particle of coal was found in the larynx or trachea, although such particles were discovered under the microscope in various portions of the lung, and also imbedded in the muscular structure of the right ventricle of the heart, into which they had bored their way; not, however, in that of the left ventricle. Another rabbit was compelled to breathe a mixture of coal and starch-powder for fifteen minutes, immediately after which it was killed, but afforded no evidence of starch, microscopically or chemically, in the lungs or in any other organ; the starch had been detained in the mucus of the upper part of the air-passages. A large rabbit was made to breathe for twenty minutes an atmosphere in which six ounces of carbonate of lead was suspended.

Evidences of the lead were found in the larynx, trachea, and main bronchi; and the lung-tissue, when dried under the microscope, showed irregular masses of crystals, identical with those of the carbonate of lead.

Dr. Rosenthal found that in foundries, in which the models are sprinkled all over with graphite before being cast, the sputa of the workmen were black-colored and somewhat greasy. On laryngoscopic examination, he found stripes of grayish-black dust collected upon the posterior pharyngeal wall, and also upon the epiglottis and the vocal cords, the mucous membrane covering which structures was greatly reddened. These workmen are well nourished as a general rule, not liable to pulmonary affections particularly, and tuberculosis among them is rare. The irritation from the inhaled graphite seems principally confined to the pharynx, larynx, and upper portion of the trachea. The writer then goes on to recount the effect of various occupations, where the atmosphere of the workroom is filled with dust; as those of bakers, grinders, apothecaries, etc. He believes that very often such substances inhaled, by keeping up a continued irritation of the bronchial mucous membrane, etc., affect the distributions of the vagus, recurrent, and hypoglossal nerves; at times, even to the extent of producing paralysis.

The investigation into the diseases to which workers in stone, glass, tobacco, coal, etc., are subjected, by Traube, Cohnheim, Leuthold, Kussman, Degen, Zenker, Selzman, Koschlakoff, Felbz, Hirt,* and many other Teutonic physicians who have given the subject great attention, prove, beyond the possibility of a doubt, that

* *Die Krankheiten der Arbeiter*, Breslau, 1873.

fine particles of dust gain entrance into the air-passages, inducing severe and often fatal affections.

PATHOLOGICAL PROOFS OF THE PENETRATION OF POWDERS INTO THE LUNG-TISSUE.

It has been known, for centuries, that certain avocations, in the prosecution of which the laborers are exposed to the inhalation of vegetable, animal, mineral, and metallic dust,—as in the grinding of grain, the making of coal-black, mining, working in coal, the manufacture of grindstones, the grinding of metals, and so on,—are productive of certain pulmonic affections, due to the dust inhaled by the workmen during their employment. Closer to our own century, and within it, we have the observations of Johnstone,* Beddoes,† Knight,‡ Gregory,§ Marshall,|| Holland,¶ and others, whom it is needless to enumerate.

To come down to more recent evidence, a case proving the penetration of particles of coal into the lung-

* Some Account of a species of Phthisis Pulmonalis, peculiar to persons employed in pointing needles in the needle manufactures. Memoirs of the Medical Society of London, 1790, vol. iv, p. 89.

† Essay on the Causes, Early Signs, and Prevention of Pulmonary Consumption, London, 1799.

‡ On the Grinders' Phthisis, in the North of England. Med. and Surg. Jour., Aug. and Nov. 1830; Am. Jour. Med. Sci., N. S., vol. ix, p. 248.

§ Case of Peculiar Black Infiltration of the Whole Lung. Edinb. Med. and Surg. Jour., 1831, No. 109.

|| Cases of Spurious Melanosis of the Lungs. The Lancet, May 17, 1834.

¶ Diseases of the Lungs from Mechanical Causes. London, 1843.

tissue, from inhaling an atmosphere loaded with the substance, is reported in detail by Prof. Traube.*

This case was a charcoal carrier, æt. 54, who had worked at his employment for twelve years, and in whose lungs, after death, particles of charcoal were detected.† For twenty years he had had a cough, and of late years had suffered with shortness of breath. For twelve years, and to within the last three months of his life, he had been almost constantly exposed to the dust of charcoal, and had often observed that his sputa were black. In his expectoration were found numerous free black particles, of very irregular, angular shape, and sometimes of large size. Some of these presented structural peculiarities identifying them with the wood of the *Pinus sylvestris*. Three months before his death he was attacked with pericarditis, and subsequently, double pleuritis, and finally, gangrenous erysipelas. At the autopsy, the lungs were found free from structural lesion, but almost everywhere of a dark black color. A copious amount of dark serous fluid exuded on pressure, staining the fingers black like India-ink, and exhibiting under the microscope black and red particles similar to those which had been found in the sputa. Some of these particles were firmly imbedded in the pulmonary cells, to which they had bored their way. Prof. Traube believes that derangement of the ciliary action of the bronchial mucous membrane is essential to the accumulation of carbonaceous matter in the lungs, inasmuch as many persons continually inhale fine dust in similarly loaded atmospheres without apparent suffering.

A similar case occurring in Prof. Traube's Klinik is reported by Dr. Leuthold,‡ in which, during life, the particles of the coal were detected in the sputa upon microscopical examination; and at the autopsy, Dr. Cohnheim detected similar particles in the very stroma of the lungs, and in the bronchial glands, proving that

* Deutsche Klinik, 1860, Nos. 49 and 50. pp. 2 to 3½.

† Schmidt's Jahrbücher, vol. 110, p. 299.

‡ Berliner klinische Wochenschrift, iii, 3, 1866; Schmidt's Jahrbücher, Band 132, 1866, p. 163.

they had penetrated into the air-cells, and had bored their way through the walls of the alveolæ.

Dr. Peacock* reports the results of the post-mortem examination of a patient who died of millstone-makers' phthisis, at the age of thirty-seven, having commenced work at that trade in his twentieth year. Portions of the indurated pulmonary tissue, and of the diseased bronchial glands, were obligingly examined by Dr. Bristowe, who furnished the reporter with the following notes : "The diseased portions of lung were much indurated, having generally an opaque whitish hue, but being thickly studded with a black pigment. Under the microscope little or no trace of original lung-structure was visible, but the diseased masses appear to be made up of dense, closely arranged, fibroid tissue, studded here and there with numerous irregular groups of black pigment, and generally with an abundance of transparent granules and globules of various sizes. The tissues were rendered comparatively transparent under the influence of strong acetic acid, the fibroid tissue becoming a little expanded, and many of the granules and globules disappearing. The bronchial gland presented characters identical with those of the diseased lung."

Dr. Peacock subjected portions of the indurated lung-tissue to ignition in the flame of a spirit-lamp. The white ash which remained, dissolved to a great extent in hydrochloric acid, and partly with effervescence ; but a portion was left which was seen under the microscope to consist of small angular transparent granules, exactly resembling the finer portions of the silicious dust col-

* Brit. and For. Medico-Chirurgical Review, vol. xxv, 1860.

lected from one of the workshops. Dr. Moldenhauer, assistant in the chemical laboratory at St. Thomas's Hospital, also subjected portions of the indurated lung to the action of fire and nitric acid, and found that a considerable quantity of gritty matter remained, which had an amorphous aspect under the microscope, and was inferred to be silicious. The bronchial gland did not contain any similar material.

At a meeting of the Pathological Society of London, held May 16th, 1865, Dr. Greenhow exhibited two morbid pathological specimens, one being a specimen of diseased lungs from a case of grinders' asthma, and the other a specimen of coal-miners' black lung. To copy the account from the Transactions of the Society :

"Specimen of Diseased Lung from a Case of Grinders' Asthma.— The specimen has been in my possession for some years. It was taken from the body of a razor-grinder, who had long suffered from grinders' pulmonary disease, but had died from an intercurrent attack of pneumonia. The portion of lung shown is from the upper lobe, near the apex; it is consolidated, but some parts are harder than others, and it is intersected by a firm white band, apparently produced by the thickening of interlobular tissue. It is now of a dark bluish-gray color, but is paler than when fresh. On examination of a thin slice under the microscope, a few small, apparently crystalline bodies, irregular in size and shape, were seen imbedded in the tissue, which also contained numerous small, well-defined, black masses of various sizes, which gave the lung its peculiar dark color. On the supposition that these latter might be at least due to the presence of oxidized iron, a very thin slice of the lung was taken and immersed for some time in hydrochloric acid; but on examination under the microscope, it was found still to present appearances identical with those already described. In order to determine the nature of the apparently crystalline bodies, a small portion of the lung was carefully incinerated in a porcelain crucible; it left a bright red ash, which partially dissolved in boiling hydrochloric acid, leaving a small residue that gravitated to the bottom of the vessel. On examina-

tion of this residue under the microscope, it was found to consist partly of an amorphous deposit, and partly of small angular masses, which reflected light powerfully, and polarized light transmitted through them. A portion of the residue being, at the suggestion of my friend, Mr. Heisch, lecturer on chemistry at the Middlesex Hospital, exposed in a shallow platinum vessel to the fumes of hydrofluoric acid, was entirely dissipated, proving it to be silica. A comparative experiment was tried with a portion of ordinary lung (from a patient who had died in the Middlesex Hospital) which, when incinerated, left an ash not quite so red as that from the grinder's lung, and altogether soluble in boiling hydrochloric acid. The solution of the ash from both lungs gave faint indications of the existence of iron, about equal in both cases; but the absence of free particles of iron in the grinder's lung was determined by bringing every part of the specimen into proximity with a delicate magnetic needle without causing any sensible disturbance.

"The disease from which the patient had suffered appeared to have been chronic, or, as Rokitansky terms it, interstitial pneumonia, and its cause was doubtless the inhalation of finely pulverized grit, given off from the revolving grindstone while the man was at work, and which, as we have seen, was found in the lung after death, in the form of small angular particles of silica.

"Specimen of Coal-miners' Black Lung.—This specimen, like the former, has been in my possession for some time. It was obtained from the body of a collier who had worked in the shallow and ill-ventilated coal mines near Wolverhampton, and was taken from the free margin of the upper lobe. The general color of the mass is dark blue, almost black; but it was quite black when fresh, at which time a black juice could readily be expressed from its substance. The pleura is thickened, and the lung is traversed by some firm white bands, apparently formed by the thickening of the interlobular tissue. The lung cuts toughly, and is very firm and solid, but not uniformly so, some ill-defined harder portions being felt in the substance when handled. Under the microscope, the lung was seen to be studded with small black deposits, apparently irregular, both in shape and size, but the examination was not made until it had been for some time immersed in spirit. On boiling a small slice in strong hydrochloric acid, the black deposit was not affected. A portion of the lung when incinerated left a red ash, closely resembling the ash left from burnt coal. When boiled in

hydrochloric acid, this ash was partially dissolved, leaving a white or grayish amorphous residue, which did not polarize light, but evidently consisted of silica, for it was dissipated on being exposed to the fumes of hydrofluoric acid.

"This case appears to have been assimilated in its pathological characters to that of the razor-grinder. The lung was similarly consolidated, and traversed by white bands. *Whatever doubt may sometimes be entertained regarding the origin of the black deposit in the lungs of colliers, it appears quite certain that in this instance it arose mainly from the inhalation of finely pulverized coal; for on no other supposition can we explain the presence of the very large amount of amorphous silica obtained from the incinerated lung.*

"REMARKS.—The result of the examination of these specimens of lung accords with the history of the symptoms from which the several classes of operatives exposed to inhale grit, or other heavy dust, are practically found to suffer. The earlier symptoms are those of bronchial irritation, namely: slight dyspnœa, cough, and scanty expectoration colored with the material inhaled. This ailment often proceeds so slowly and insidiously that the sufferer is scarcely aware of its existence until it becomes aggravated by some attack of catarrh, and more or less disables him from working. Hence, overlooking the previous indisposition, he, for the most part, dates the commencement of his illness from the occurrence of a cold. In a great many instances, and especially those in which the dust inhaled is of a light description, the disease often remains bronchial throughout, and presents only the ordinary characters of chronic bronchitis, with or without emphysema. But in other cases, and especially in those in which a heavy dust, such as that given off in the processes of razor-grinding or china-scouring, has been inhaled, chronic pneumonia supervenes after a time, and frequently proves fatal, either in consequence of an intercurrent attack of acute pneumonia, or after a long chronic course with symptoms resembling those of very chronic phthisis. Dyspnœa is always a very marked feature of such cases, and is sometimes so extreme as to prevent active locomotion, even while the patient is still able to continue his occupation. The physical signs are also out of all proportion to the amount of disturbance of the general health, which, in constitutionally sound subjects, is much less than in those who are the subjects of pulmonary disease arising from constitutional cachexia. Sometimes, even when the complaint appears to be far advanced, the discontinuance of exposure to the

determined cause, viz., the inhalation of dust, is followed by a most marked improvement in health."

Prof. Zenker* relates in detail a case of an operative, æt. 31, who had been employed during life in preparing the paper-books for the gold-leaf fabric, and who died in 1864, after an illness of eight weeks. The powder employed is that known as English red, a compound of iron, which is used in the form of a dry impalpable powder, and rubbed into the paper with felt. The atmosphere of the workroom becomes so filled with the dust as, in a few minutes, to dry the pharynx of strangers unaccustomed to the atmosphere. The lung of this patient had a red color; and on chemical examination, Prof. von Gorup-Besanez found oxide of iron in large quantities as fine molecules in the air-passages, and to a greater extent in the lung-tissue itself; besides, also, in the bronchial glands, and still further; showing that the particles, after penetrating the interstitial tissue, had been carried onwards by the lymphatic system.

A solution, in hydrochloric acid, of 55 grammes of the incinerated ash of this lung-tissue, was found to contain 0.828 grammes of oxide of iron: therefore, 14.5 grammes, or about half an ounce to 1000 grammes; or in the proportion of three-fourths of an ounce in the entire lungs, which, in the present instance, weighed 1500 grammes, the left lung weighing 720, and the right 780 grammes; much in excess of the normal weight of the female lungs, which, according to Krause, is 1050, according to Dieberg, 1073 grammes.

In order to determine the specific gravity, a comparative experiment was made with the healthy lung of a

* Deutsch. Arch. für klinische Med., 1866, vol. xi, p. 116.

robust man of forty years of age, who died of another affection, and with the compressed lung of an old man, who died of pleuritic exudation, care being taken to remove by frequent washing, etc., all sources of error which might invalidate the experiment. The result is shown in the following table:

	A portion of the oxidized lung;	Of the sound lung;	Of the com- pressed lung;
Weighed in air, . . .	7.210 gr.	8.810 gr	12.02 gr.
Weighed in water, . . .	0.440	0.130	0.03
Loss of weight in water, . . .	<u>6.770</u>	<u>8.680</u>	<u>11.99</u>
The sp. gr. being . . .	1.065	1.015	1.0025

To demonstrate more clearly the increased weight, equal portions were taken from the above specimens, and likewise from the sound lung of a boy of fifteen years of age, which were allowed to drop to the bottom of a glass cylinder, filled with water to the height of forty-five centimetres; when it was found that the oxidized lung fell in thirteen seconds, upon a first, second, and third trial; that the piece of sound lung from the robust man aged forty, fell in twenty-six seconds on the first trial, in twenty-five seconds on the second trial, and in twenty-six seconds on the third trial; the piece of sound lung from the boy aged fifteen, fell in thirty seconds on the first and second trials; and the specimen of compressed lung from an aged man fell in thirty-one seconds on the first trial, in thirty-two seconds on the second trial, and in thirty-two seconds on the third trial.

A second case is related with similar results as to the detection of oxide of iron in the air-passages and lung-tissue, in a patient who had been employed in backing glass mirrors, the English red being used for the purpose of rendering the metal adherent.

The sputa of a similar operative, examined twelve hours after leaving off work, were found to contain the oxide of iron, upon chemical and microscopical investigation.

The results of many other post-mortem examinations have given the same results. Thus may be mentioned the cases recorded by Pearson,* Biehat,† Laennec, Troussau, Erdmann,‡ Loewe,§ Broekmann,|| and many others.

Dr. L. Petrenz,¶ found stony concretions the size of a hazel-nut in purulent pulmonary cavities.

With regard to the black pigmentary matters found in the lungs of deceased coal-miners, and others who have worked in atmospheres loaded with coal-dust, some authors deny altogether their penetration into the pulmonary organs; others contend that they may be inhaled, but that, being insoluble, they are expectorated; others not only admit their penetration, but are of opinion that they accumulate, act deleteriously, and produce alteration of structure.

Virchow is one of those who contend that these appearances are not due to the inhalation of particles of coal-dust; which, according to him, if inhaled, would be extruded with the bronchial mucus. He considers the affection pigmentary, and due principally to obstruction of the mitral valve dependent upon a chronic hyperæmia of the lungs, the result of a detention of the blood in the pulmonary veins.

* Philosophical Transactions, 1813, p. 160.

† Traité d'anatomie descriptif, 1819, t. iv, p. 22.

‡ Journal der prakt. Heilkunde, Dec. 1831, vi, p. 3.

§ Bd. lxxxvi, vi, p. 16.

|| Die metallurgischen Krankheiten des Oberharzes, etc., 1851.

¶ Lewin, op. cit., p. 11.

Bayle recorded two cases which he attributed to a circumscribed melanosis; and Lacnne, in commenting upon this view, rather refers the black deposit, as at least in part due, to inhalation from the smoke of the lamp or other products of illumination in general use, as it was sometimes discovered in the lungs of nurses accustomed to sit up at night with the sick.

It is also found in the lungs of other miners, not colliers, who work with lamps suspended over their heads.

Others, again, are of opinion that the carbonaceous material or lampblack thus inhaled, accumulating, forms a nidus for the attraction of further carbonaceous matter from the blood. This view seems to be worthy of a good deal of consideration, for it has been found that by washing the lungs containing such deposits, two materials are secured—one a vegetable carbon not acted upon by the solvents which will readily dissolve the other or organic pigmentary matter.

While it is true that much of the matters inhaled would be thrown out of the system with the bronchial secretions, it must be remembered that some portions will be too heavy to be cast out against gravity, by the mere motion of the bronchial cilia, while other minute sharp-pointed particles, will bore their way through the epithelium, and thus eventually become imbedded into the very pulmonary tissue, as indeed appears to have been the case in the examples cited, similar evidence to which can be readily increased by adducing further records.

We know, too, that workmen who remain long at a time in apartments filled with fine dust,—for instance, bakers, weavers, chimney-sweepers, artificers in stone,

etc.,—are peculiarly liable to diseases of the lungs. Thus Dr. Peacock,* calling attention to the form of phthisis to which the French millstone-makers are subject, explains how it is contracted. The rough working of the stone is effected by a steel chisel, "the pritchel," which is struck by a metal hammer, and the surfaces are finished by picking with a double-pointed steel instrument fixed in a wooden handle—the "bill and thrift." As the burr is extremely hard (it is the "French burr," situated in the Paris basin above the gypsum containing bones, and in strata of sand and sandstone, and is harder to work than gun-flint), every stroke of the chisel is attended by a flash of light and a cloud of dust; and larger or smaller particles of stone, forming a sharp grit, are thrown off. Portions of the stone and of iron from the chisel not infrequently become imbedded in the hands of the workmen, so that the backs of the hands of those who have been long at the trade are studded with small bluish spots; and occasionally the men sustain serious injury to their eyes. The mortality of these workmen is very great, so that of fifty workmen, about twenty will die of pulmonary disease within a few years, and they seldom live beyond forty years of age, especially if they begin to work at the trade in early life before their full physical development has been acquired. Dr. Peacock found in four workshops forty-one workmen, of whom the eldest was but thirty-eight years of age, and those next oldest twenty-nine and twenty-eight respectively. Most of them had before them, on an average, but eight or nine years more of labor. It is a remarkable fact that these workmen, knowing their condition and the result

* Brit. and For. Med.-Chir. Rev., vol. xxv, 1860, p. 215.

of a continuance at their avocation, seem thoroughly satisfied with it. Their wages are high (5s. per day), their dwellings and workshops are healthy, and they are well clothed. They drink freely of ardent spirits, which is said to preserve their strength and enable them to exist longer.

Prof. Dickson, of Jefferson Medical College, Philadelphia, when lecturing upon the causation of disease, used to draw the attention of his class prominently to the fact that many diseases are necessary results of the occupations of civilized life, and he would instance the wet and dry grinders in England, who have long been doomed to premature old age and death, from the wearing away of the stone in "foamlike surges," which fill the lungs and thus induce fatal disease;—for a dry grinder rarely reaches thirty-five, or a wet grinder forty-five years of age;—quoting the following lines from *Elliot's Corn-Law Rhymes*, showing how these grinders, like the millstone-makers, continue at their trade on account of its high wages and the opportunity presented for affording the means of alcoholic stimulation:

"There draws the grinder his laborious breath ;
There, coughing, at his deadly trade he bends ;
Born to die young, he fears nor man nor death ;
Despair and riot are his bosom friends.
Bid science on his cheek prolong the bloom !
He will not live—he seems in haste to gain
The undisturbed asylum of the tomb ;
And, old at two-and-thirty, meets his doom."

As a pathological proof of the penetrability of fine powders into the respiratory passages, I may instance a number of cases which occurred in a family living over a perfumery store which caught fire in this city some

years ago. The family breathed the stifling smoke, and ten of them who came under the care of Dr. W. W. Keene, Jr., and myself, were attacked with severe bronchitis, with aphonia; and for several days subsequent to the accident they expectorated large quantities of black sputa, which were nothing more nor less than the carbonaceous matters they were forced to inhale during the conflagration, before they could be rescued.

Prof. Da Costa, of Philadelphia, in a foot-note to the reprint of his essay on Inhalation, states that his attention had been called by Dr. Fleming, of Pittsburg, to the rapidity with which men repairing copper work which had been used for steam, water, etc., become affected by the impalpable oxide of copper therein formed. Dr. Fleming himself, having been exposed for a few minutes to the same influence, and the quantity breathed having been very minute, was astonished at the great effect experienced; constriction about the chest, most active salivation, and so on.

ARTICLES OF THE MATERIA MEDICA EMPLOYED BY INHALATION OR INSUFFLATION IN POWDER.

Powders, in an impalpable form, can be taken with the inspiratory current into the bronchial tubes in small quantities. When the medicinal agent is too irritant in the undiluted state, or too small in bulk for convenient use, it may be rubbed up with rock candy, sugar of milk, talc, liquorice root, or some other indifferent or innocuous material.

Care must be taken that none of the powder is swallowed, if of such a nature as to provoke nausea, or induce any injurious effect upon the stomach or the system at large.

The use of powders by inhalation or insufflation is limited. They are often more efficacious in acute affections of the larynx than solutions; and even in chronic affections are sometimes better borne, though the general indication for their use is less frequent.

The remedies thus employed in the form of powder are not very numerous, and the reports of their therapeutic uses are quite meagre.

The following list comprises nearly all of them.

ALUM.

Alum is used pure or diluted with one or more parts of sugar of milk or some indifferent material. Burned alum is sometimes used in preference. It has been employed in coryza, catarrhs of the pharynx, larynx, etc., in aphthæ, in tonsillitis, the sore throat of small-pox, œdema of the glottis (Laenée*); and in croup and diphtheria (Pommier, Bretonneau, Trousséan), fifteen grains with sugar being blown on the parts several times a day in diphtheria.

TANNIN.

Tannin is used alone or diluted with sugar of milk, or combined with other ingredients, as alum, borax, and the like. It has been employed in chronic and fetid coryza. Some authors have recommended equal parts of tannin and camphor, with double the quantity of high-dried Scotch or Welsh snuff in chronic coryza, a pinch being snuffed up into the nostrils when they are more obstructed than usual. I have occasionally seen benefit from the practice. It is sometimes employed in

* Rev. méd., Oct. 1828; Am. Jour. Med. Sci., vol. iv, p. 500.

combination with equal parts of alum or borax, or rubbed up with mallow root, two to five grains to the drachm, a pinch being snuffed up the nostrils, three or four times a day, in coryza. It is sometimes used in the same manner after the evulsion of nasal polyps. Waldeburg has reported good results under such circumstances. In fact, the insufflation of pulverized tannin was at one time extolled as a remedy capable of destroying these polyps,* several cases of apparently permanent cure having followed a treatment extending from ten days to a month. Of late, little has been heard of this remedy in the connection alluded to; but although it may be incompetent for the destruction of polyps, it is certainly capable of modifying the catarrhal condition of the membrane upon which the existence of these growths in great part depends; and hence it is of good service as an application to the parts after the removal of the growths.

Powdered tannin is likewise occasionally employed with more or less benefit in chronic catarrhal inflammations of the pharynx and larynx.

BORAX.

Borax, pure, or mixed with equal parts of sugar, alum, or tannin, is used in aphthæ, coryza, and catarrhal inflammations of the pharynx, larynx, and trachea.

BISMUTH.

The subnitrate of bismuth, one part to one, two, or more parts of sugar of milk, or the like, was much used by Troussseau in relaxed conditions of the mucous mem-

* Bryant, *The Lancet*, Feb. 23d and Aug. 24th, 1867.

brane of the nose and pharynx, unattended with marked inflammation. Dr. Ludlow, of Philadelphia, has used this preparation locally with much success in chronic affections of the nasal mucous membrane, led thereto by its peculiar sedative influence on the gastric mucous membrane when taken internally. It is sometimes used to give body to more active powders, when it is desirable to reduce them.

NITRATE OF SILVER.

Nitrate of silver in powder is usually employed, diluted with from twenty-four to seventy-two parts of sugar of milk (Trousseau), with five to twenty-five parts of burnt alum (Waldenburg), or with from one to six parts of commercial tale (Bruns). Some practitioners use less sugar, from one to ten (Barbier), or from five to twenty-five parts (Waldenburg).

Trousseau employed this agent in cases of known or inferred ulcerative inflammations of the pharynx and larynx; Burow, in chronic laryngitis, three grains to the drachm; Ebert, in laryngitis,* in the same proportion; Thomas, in chronic inflammations of the upper air-passages, a few whiffs of the impalpable powder undiluted; Barbier, in coryza, one part to ten, a pinch three or four times a day;† Bruns, in chronic inflammations, beginning with six parts of tale, and gradually reducing the proportion of the tale to equal parts; Waldenburg, in catarrhs, one part to from five to twenty of the excipient. Pserhofer reports‡ several cases of pulmonary gangrene successfully treated by inhalations (from a box) of a powder composed of one part of nitrate

* Am. Jour. Med. Sc., Oct. 1853, p. 515.

† Edinb. Med. Jour., May, 1872, p. 1049.

‡ Loc. cit.

of silver with from four to six parts of lycopodium ; and likewise cases of chronic catarrhal bronchitis, tuberculosis, etc.

MERCURY.

Mercury is usually employed in the form of calomel ; but sometimes in the form of the red oxide also. Troussseau employed the former in the proportion of one part to twelve of sugar of milk, and the latter in the proportion of one part to thirty-six. Calomel is sometimes used pure, or diluted with but one to five parts of sugar of milk or ordinary white sugar. Troussseau employed these mercurials not only in syphilitic cases, but in non-specific ulcerations also. He likewise employed them in fetid coryza, a pinch of the powder being snuffed up from ten to twelve times a day. Bretonneau* employed calomel powders by insufflation in diphtheria, both laryngeal and nasal, and also blew them into the tracheotomy wound in cases that had been operated on ; as much as from twenty to forty grains, with powdered gum, being inhaled during the treatment of the case.

Waldenburg warmly recommended calomel by insufflation in syphilitic affections of the mouth and nostrils, one part to ten of white sugar.

ANTIMONY.

Preparations of antimony are sometimes of great service in the early stages of acute laryngitis and pharyngitis ; and they may be combined with hyoscyamus and the like, to relieve pain, and with chloride of ammonium to promote secretion. The oxysulphuret is the prepara-

* Op. cit., p 141.

tion that I have usually employed, rubbed up with from one to four parts of pulverized liquorice root, or some other indifferent material; a pinch or so every three or four hours.

SULPHUR.

The insufflation of powdered sulphur has been recommended in croup and diphtheria. First employed by Barbosa in 1867;* it was brought into notice by Ullersperger,† and especially by Lutz,‡ who vaunts it as almost a specific cure. Loevinson§ and others, including myself,|| have also reported successful experience in the treatment of diphtheria with powdered sulphur. Hanner¶ denies its beneficial influence on the disease.

MORPHIA.

Acetate, Muriate, and Sulphate of Morphia.—The salts of morphia are usually rubbed up with some indifferent powder as gum arabic, lycopodium, or the like. Fieber recommends from one-sixtieth to one-fiftcenth of a grain of the acetate or muriate at a time, with one-third of a grain of oxide of zinc, in irritable sore throats.

Prof. Schrötter,** of Vienna, recommends the local use of powdered morphia to relieve the pain, in cases of

* *Gazetta medica de Lisboa*, March, 1868.

† *Journal f. Kinderkr.*, 1868.

‡ *Die Epidemische Diphtheritis und ihre schnellste Heilung*, Würzburg, 1870.

§ *Berlin klin Woch.*, 2, 1872.

|| *Diseases of the Throat*, New York, 1872, p. 101.

¶ *Journal f. Kinderkr.*, 1870, 1, 2.

** *Jahresbericht der Klinik für Laryngoskopie, an der Wiener Universität*, 1870, p. 58.

ulcerative laryngitis, in the proportion of from one to four grains to the ounce of some innocuous material, a suitable portion of which he propels from an insufflator directly upon the ulcerated parts. He prefers gum arabic or sugar as his menstruum. Sugar, however, sometimes increases the suffering for the time, although it also seems at times to exert a beneficial influence on the ulcerative action, facilitating the discharge of the slough. Guéneau de Mussy* and others recommend the insufflation of morphia into the nostrils in the treatment of facial neuralgia, a pinch, every two or three hours, of a powder composed of one part of morphia to twenty of pulverized mallow root.

OF OTHER REMEDIES employed by insufflation or inhalation, we may mention

CAMPHOR, alone, or with tannin or snuff, in acute coryza and chronic nasal catarrh.

MYRRH, which, according to Waldenburg, deserves to be used in many cases of catarrh with copious secretion.

- COMMON SALT, in coryza.

CHLORATE OF POTASSIUM, in aphthæ and diphtheria.

CARBONATE AND BICARBONATE OF SODIUM, in coryza and catarrhal pharyngo-laryngitis.

CHLORIDE OF AMMONIUM, in coryza, and in pharyngitis sicca.

ACETATE OF LEAD, one part to five or more of sugar, in chronic coryza, and in catarrhs with copious secretion.

SULPHATE OF IRON, one part to twenty or more, in chronic coryza, and less diluted, even pure at times, in cases of multiple nasal polyps, after removal of the main masses.

* Gaz. des hôp., June and October, 1867.

SULPHATE OF ZINC; OXIDE OF ZINC.—The preparations of zinc are employed undiluted, or mixed with from one to thirty-six parts of sugar of milk, alum, tannin, or the like. They have been chiefly employed in catarrhal inflammations (Trousseau, Fieber).

SALICYLIC ACID has been employed with advantage in fetid coryza, after due cleansing of the parts from mucus, pus, and the like. A pinch is snuffed up, at intervals, of a powder containing one part each of salicylic acid and lycopodium to four of starch, or six of subnitrate of bismuth (Ludlow, of Philadelphia).

PART IV.

MEDICATED ATMOSPHERES.

ATMOSPHERES naturally or artificially impregnated with medicinal agents, are frequently prescribed for the treatment of affections of the respiratory organs, and sometimes for the treatment of other affections also. The patient either resides permanently, or for a time, in the medicated atmosphere, or else passes a certain number of hours a day in it during the continuance of the treatment.

Among the ancients, Aretæus, Celsus, and the elder Pliny recommended sea-air in consumption, and Pliny likewise recommended residence in pine-forests as more beneficial than a voyage to Egypt, or a course of milk in the mountains. Galen not only recommended patients with phthisis, and with laryngeal and tracheal ulcerations, to reside on the sea-coast; but also sent them to the vicinity of Mounts Vesuvius and Ætna that they might breathe, in addition, an atmosphere impregnated with sulphurous emanations. From time to time, similar atmospheres have been recommended in various chronic diseases of the respiratory organs; and where the natural atmospheres were out of reach, artificial substitutes have been resorted to.

Thus, “aspiratory chambers” have been found in the remains of many Roman baths.*

* Sales-Girons, *Thérapeutique Respiratoire*, Paris, 1858.

Nicolas Piso (1527-1579) recommended hot dry air in consumption, and mentioned a case of recovery in a female, in consequence of her attendance on a bakehouse.

Bennett, of London (1654), expressed the belief that by the use of suitable vapors or medicated effluvia, sitting apartments might be made useful substitutes for voyages to Egypt and other warm countries.

Bartholin (1654) likewise thought that by the use of proper vapors, a sitting-room might be made a substitute for a voyage to Egypt.

Atmospheres impregnated with the fine dust of fresh earth in suspension, as first recommended by Solano, of Luque, in the form of the earth-bath, were considered as possibly salubrious by Van Swieten, and were recommended by Fouquet, Hufeland, and others in phthisis. They are still employed at Ischl and other resorts on the European continent. Demarquay* believed that the beneficial effects of the emanations from earth-baths are due to the carbonic acid of which they are in great part composed.

Residence in the immediate vicinity of cow-houses, stables, and the like, or even in apartments directly communicating with them, so that the atmosphere breathed by the patient should be continuously impregnated with the warm ammoniacal emanations from the animal exhalations, were highly recommended in phthisis by Read,† Beddoes,‡ and others, in the latter part of the

* *Essai de pneumatologie médicale*, Paris, 1866, p. 471.

† *Essai sur les effets salutaires du séjour des étables*. London and Paris, 1767.

‡ *On a new method of curing Pulmonary Consumption, and the Cow-stable Cure*, Bristol, 1793.

eighteenth century; but this plan of treatment, though at one time vaunted as highly successful, soon fell into disrepute, and subsequently into disuse. The beneficial results from the practice were at first attributed to the ammoniacal and other animal exhalations. Fourceroy, however, shrewdly suspected that they were rather due to reduction of the purity of the atmosphere, which might be too rich in oxygen; while Beddoes attributed them to the uniform warmth of the atmosphere, by the artificial maintenance of which, in other manners, he was able to obtain equally good results.

In a similar manner, sojourn or residence in sugar manufactories was recommended in consumption by Beddoes and others, for the sake of the carbonic acid with which the atmosphere of such establishments is impregnated.

The warm vapors from tanneries were recommended in like manner by Elliotson and others;—and the list might be further increased.

In the foregoing pages, mention has been made of atmospheres artificially impregnated with aromatics (p. 180), balsams (p. 133), bromine (p. 111), camphor (p. 166), carbolic acid (p. 155), carbonic acid (p. 87), carburetted hydrogen (p. 87), chloride of copper (p. 177), chloride of ammonium (p. 116), chlorine (p. 31), hydrogen (p. 83), iodine (pp. 97, 101), oil (p. 139), ozone (p. 136), resins (p. 136), salt (p. 270), sulphur (p. 112), sulphuretted hydrogen (p. 83), tar (p. 140), turpentine (p. 144), and vapor of water (pp. 177, 183).

The experiments of Laennec to produce an artificial sea-air for consumptive patients (p. 97), though not promising in their results, have been imitated by others,

but in a different manner. Thus Hirzel,* of Zurich, sprinkled an artificial sea-water from a small fountain, in the apartments of consumptive patients. He was followed by others; and various establishments have been constructed at certain European thermal and other springs, where there are so-called "vapor promenades," as at Ischl, Nanheim, etc., the saline constituents of the mineral waters being forced up mechanically in the vapors which rise from the boiling springs. In other places the water is boiled, and the vapor conducted into apartments to which the patient resorts to breathe in the impregnated atmosphere.

Then, there are establishments in which salt-water sprays are continuously being projected into the atmosphere to which patients resort at certain hours of the day, remaining in the atmosphere for an hour or so at a time. One example will suffice for the whole:

"At Reichenhall, a celebrated cure in Bavaria,† a method of treatment is adopted in which the patient lounges in the immediate neighborhood of the drying-houses near enormous hedges, forty or fifty feet high, composed of bundles of twigs arranged horizontally, so that their projecting ends form the surface of the wall. The water is conveyed to these hedges by pipes, and is allowed to trickle over the bundles of twigs into reservoirs, whence it is conveyed into vats, and undergoes further evaporation by the aid of heat. The air is richer in suspended saline particles (0.054–0.123 grains in the

* Ueber die künstliche Seeluft als Heilmittel gegen tubercülose Lungen- und Luftröhrenschwindsucht. Schweizer Cant.-Ztschr., 1845, Nos. 1, 4; Schmidt's Jahrb., Bd. li, p. 284.

† J. Burdon-Sanderson, Practitioner, London, Oct. 1868, p. 217.

cubic foot) than sea-air is. The researches of Prof. Vogel and Dr. von Liebig show that about ten grains of salt are actually taken into the respiratory apparatus in the hour; which is only two grains less than the amount taken in when the water is nebulized into spray in the inhalation rooms of the cure. Dr. Sanderson believes that the beneficial results of the saline atmospheres are due to their effect in increasing the tendency to molecular disintegration, *i. e.*, to oxidations throughout the body. These inhalations are of great value in chronic catarrhal affections of the digestive and respiratory mucous membranes."

Similar vapor promenades are established at Kreuznach, Kösen, Elmen, Salzungen, and other German resorts. A patient of mine, who spent some time recently at the cure at Salzungen, reported to me, on his return, that the ground became very wet, and that despite the precautions taken with water-tight shoes and the like, he found the ill effects from saturation of his feet more than counteract the good effects from the inhalation of the saline atmosphere.

In cases of infective and contagious diseases, and under other circumstances in which it is desirable to prevent contamination of the atmosphere with the emanations from a patient or his discharges, or when it is desirable to disinfect an atmosphere already so tainted, we have a ready means of diffusing a purifying agent through the atmosphere of an apartment, by resorting to the process of nebulization, so as to divide it in the most minute manner possible. In this manner, one or more instruments can be placed in action in different portions of the room, and kept up sufficiently to maintain a comparatively pure atmosphere.

Then, also, in cases of disease where we wish to medicate the atmosphere with which the patient is surrounded, as with a terebinthinate or other impregnation, or simply to supply moisture, or to create an artificial sea-air, we can place one or more instruments in convenient localities and keep up such a medication as is required, or renew it at proper intervals. So, too, in cases where patients are too feeble to make any effort at inhalation, and where it is impossible or imprudent to call their attention to the process, an instrument may be set going in close proximity to them in such a manner that a portion of the air they inspire shall contain more or less of the nebula.

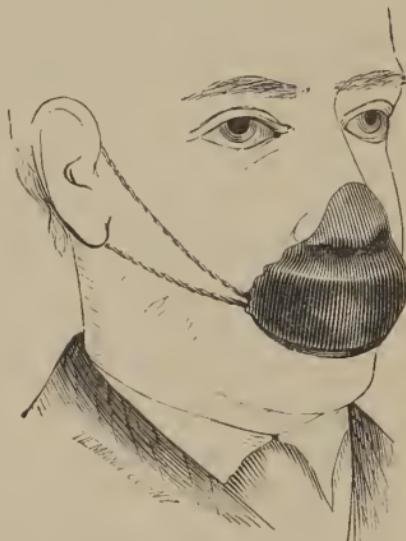
Mention has already been made (p. 349) of the diseases to which certain classes of laborers are subjected from breathing the dust accumulating in the atmospheres in which they are working. Attempts have been made at times to provide methods for preventing the inhalation of these dusts. Pliny mentions that workers in mines fastened bladders before their mouths, and that the Roman bakers placed cloths in front of their faces, when working in atmospheres loaded with these dusts.

Of late years respirators with metallic meshes small enough to detain the deleterious particles of dust have been recommended to be worn over the mouth and nose during exposure to the injurious atmosphere. They are sometimes lightly packed with raw cotton, which detains fine particles which pass through the meshes, while it still permits the access of the air. Similar contrivances, impregnated with disinfectant solutions, are sometimes employed during exposure to poisonous atmospheres.

It is often found that patients with phthisis, chronic bronchitis, or even only with delicate respiratory mucous

membrane, are unable to face the open air on inelement and windy days. Sometimes patients are unable to withstand the changes of temperature, even on days that promise to be pleasant. Under such circumstances they are compelled to keep the house, or to muffle the mouth and nose with a handkerchief, veil, or something of that kind when they go out into the open air. The

FIG. 29.



Oro-nasal Respirator.

temperature of the air is modified by the warmth of the comforter, maintained by the air of expiration ; while at the same time, if too rich in oxygen, its pungency is moderated. Unmitigated sunlight is sometimes too irritating to sore eyes ; and in like manner unmitigated atmospheric air is sometimes too irritant to sore throats, bronchi, and lungs. In Great Britain a respirator of fine metallie netting covered with silk is much used, and if properly appreciated, would be much used in this country also. Some respirators are made merely to

cover the mouth, so as to encourage nasal or normal respiration, and others (Fig. 29) to cover both mouth and nose. These appliances are unsightly, but their use often enables patients to take regular outdoor exercise, in carriage or on foot, instead of being compelled to remain indoors, almost constantly, for fear of catching cold.

In 1848 Sales-Girons suggested the regularly supplying diseased lungs with a respiratory pabulum, suitable to their condition, on similar grounds to those defining suitable diet in diseases of the digestive organs; and this he called a "respiratory diet." Some resin, tar, or balsam, or whatever was intended to medicate the inspired air, was placed within a respirator, to be worn in front of the patient's mouth, thus keeping him in the medicated atmosphere all day long, without confining him to one locality, and enabling him even to attend to his business without exposure to the unmitigated oxygen of the atmosphere, often prejudicial in many cases of diseases of the pulmonary organs.

After several years' experience, Sales-Girons still maintains* that respiration is susceptible of diet as easily as digestion; and for the purpose of supplying this diet he employs various substances, placed in the little apparatus, which the patient carries about him the greater part of the day, applied over the mouth and nostrils, to modify the atmosphere before it gains access to the respiratory tract. He contends that the respiratory diet is in accordance with a theory of relations between the living organism and the atmosphere, or the theory of relations of the lungs with oxygen.

* *Gazette hebdomadaire*, February 17th, 1860, p. 108.

In the discussion which ensued at the Parisian Academy of Medicine, upon Bouillaud's report upon the work of Sales-Girons,* M. Fontan put the query whether there was not in this production of Sales-Girons the germ of a grand discovery, that of a third state of oxygen, oxygen negatively electric, or sub-oxygen, in contradistinction to oxygen positively electric, ozone or sur-oxygen, and ordinary oxygen or neutral oxygen?

According to Prof. Dickson,† we would anticipate some soothing influence from the inspiration of air made to contain a less quantity of oxygen, which is generally regarded as a stimulant. He refers, however, to atmospheric mixtures with nitrogen and hydrogen, and with carbonic oxide or carbonic acid; and accounts in a similar way for the advantages said to have been derived by some consumptives from residing in stables with cattle, so much in vogue in England in the time of Darwin and Beddoes.

This method of keeping up a peculiarly medicated atmosphere is much the same as Sales-Girons's respiratory diet.

Prof. Max Langenbeck‡ devised an oral inhaler (see p. 29) for the same purpose, which he recommended for use in various diseases, with suitable medicaments.

Still more recently, Dr. Oliver Somerville§ has suggested the same method for keeping patients in a carbolated atmosphere in phthisis, emphysema, and putrid bronchitis.

In certain cases of phthisis and chronic bronchitis,

* Gazette hebdomadaire, January 4th, 1861.

† Elements of Medicine, Philada., 1855, p. 624.

‡ Deutsche Klinik, 1861, No. 3.

§ The Lancet, July 8th, 1871, p. 45.

where it is impracticable or injudicious to send the patient to a warm and equable climate during the winter, much benefit will often accrue from imitating the climate artificially at home. Two well-ventilated communicating rooms may be suitably warmed, and kept constantly at a uniform temperature, and the atmosphere may be impregnated with resinous emanations from pine saplings in the sitting apartment, or may be otherwise medicated by some of the methods already described. In these rooms the patient should live. At certain hours of the day, when the outer atmosphere is warmest, say between twelve and two o'clock in the day, the patient can put on hat and over-clothing, as for a walk in the streets, and promenade the rooms for half an hour or longer, the windows being freely opened to secure an ample supply of fresh air during the exercise. In this manner the benefits of equable temperature and regular exercise in the open air can be secured without foregoing the comforts of home and the satisfaction of family intercourse. Some of my patients have pursued this plan with great advantage, and have apparently done better than they would have done in a milder climate, subjected to the discomforts and privations of a boarding-house or hotel life among strangers, and exposed to the baneful influence of constant or frequent contact with invalids.

INDEX.

Abdominal obstructions, 63
Abrahams, on oxygen in asphyxia, 68
Absorption, power of, by respiratory mucous membrane, 265
Acetate of lead, 298, 337, 342, 368
Acid, acetic, 152, 181
 carbolic, 13, 46, 115, 154, 308, 313
 carbonic, 13, 83, 114, 200
 bydrocyanic, 114, 163, 333
 lactic, 322
 nitrous, 81
 pyroligneous, 154
 salicylic, 369
 sulphuric, 112, 322
 sulphurous, 112, 321
 tannic, 289
Acidulated fumigations, 153
Æsculapius, apparatus of, 336
Air, artificial sea-, 97, 373
 cold, 36
 compressed, 37, 58, 200
 condensed, 37, 58
 fresh atmospheric, 33, 75
 rarefied, 37
 sea, 370
Albuminuria, 78
Almond oil, 269
 water (bitter), 329, 333
Alum, 245, 284, 337, 363
Aluminium, nitrate of, 304
Ammonia, 113, 155
Ammoniacal exhalations, 372
Ammoniacum, 134, 136
Ammonium, 113
 bromide of, 309
 carbonate of, 113
 chloride of, 13, 32, 115, 274, 368
Amyl, nitrite of, 13, 131
Analogy between compressed air and oxygen, 66
Anæmia, 39, 65, 66, 77, 80, 132, 280
Angina, 38, 336
 pectoris, 120, 131
Animal exhalations, 372

Aniseed, 150
Anstie, on arsenic in cardiac neuralgia, 171
Antimony, 366
Antiseptics, 166, 289, 315
Aphonias, 38, 95, 108, 113, 124, 125, 135, 147, 173, 264, 266, 268, 279, 287, 294, 312, 327, 337
Aphthæ, 276, 363, 364, 368
Apnoea, 58
Apparatus for sprays, 184
 for tar vapors, 142
 of Æsculapius, 336
Aretæus, 336
Arnold, 200
Auphan, 184
Beigel, 211
Bergson, 196, 198
Berkart, 43
Biedert, 49
Burow, 338
Chambers, 342
Clarke, 199
Codman and Shurtleff, 208
Cohen, 205, 210
Corrigan, 31
Darwin, 336
Dobell, 44
Fournié, 192
Fränkel, 52
Gilewski, 340
Hauke, 43
Hippocrates, 13
Jackson, 172
Lewin, 32, 118, 190, 194, 204, 339
Mans, 203
Mathieu, 188
Matthews, 343
Mudge, 20
Pancoast, 94
Porter, 182
Pretty, 182
Pserhofer, 338
Rauchfuss, 341

Apparatus, of Read, 211
 Richardson, 203
 Sales-Girons, 184, 185, 190, 377
 Sass, 201
 Schnitzler, 191
 Seudamore, 23
 Siegle, 206
 Störek, 56, 339
 Thomas, 342
 Treutler, 57
 Troussseau, 337
 Waldenburg, 45, 190
 Walford, 32
 Winterich, 201
 Appetite, stimulation of the, 15, 64
 Arabic, gum, 270, 311, 368
 Aretæus, apparatus of, 336
 Armand, on opium, 157
 Arnica, 179
 Arnold, nebulizer of, 200
 Aromatic sulphurous acid, 322
 Aromatics, 14, 180
 Arsenic, 14, 170, 306
 Asphyxia, 59, 67, 68, 69
 Aspiratory chambers, 370
 Assafetida, 334
 Asthenia, 77
 Asthma, 35, 36, 38, 39, 59, 63, 65, 77, 84, 87, 112, 113, 114, 119, 120, 121, 122, 131, 144, 152, 157, 159, 161, 162, 163, 165, 170, 171, 179, 266, 269, 271, 275, 306, 311, 321, 330, 331, 332, 333, 334, 353
 Atelectasis, 59
 Atmospheres, impregnated or medicated, 13, 30, 87, 97, 101, 111, 112, 116, 133, 137, 166, 177, 180, 183, 197, 270, 370, 374, 378, 379
 Atmospheric air, 33
 Atropia, sulphate of, 332
 Auphan, on penetration of nebulized fluids, 229
 on sprays, 184
 Aural catarrh, 39
 Bader, on nitrite of amyl, 133
 Baillie, on tar, 141
 Balsams, 30, 122, 133, 307
 Barthez, on tannin by spray in croup, 291
 Bataille, on penetration of nebulized fluids, 229
 Baumgärtner, on chloroform, 119
 on ether, 122
 Beddoes, on ether, 121
 on hydrogen, 82
 Beddoes, on nitrous oxide, 80
 on oxygen, 62
 on tar, 140
 Beigel, mouthpiece of, 22
 on diphtheria, 73
 on milk, 257
 on oxygen, 71
 on proportion of nebula inhaled, 247
 steam nebulizer of, 211
 Belladonna, 159, 160, 164, 179, 309, 331
 Bennet, on artificial balsamic atmospheres, 133
 Benzine, 91, 154
 Benzoïn, 134, 135, 264
 Bergson, nebulizer of, 196, 198, 258, 280
 Berkart, apparatus of, for rarefied air, 43
 Bertin, on compressed air, 37
 Berton, on iodine, 97
 Besson, on ether in croup and diphtheria, 126
 Bicarbonate of sodium, 267, 273, 368
 Biedert, apparatus of, for compressed and rarefied air, 49
 Biniodide of mercury, 306
 Birch, on oxygen, 62
 Bismuth, 337, 364, 369
 Boils, 78
 Borage, 159
 Borax, 136, 363, 364
 Bottger, on ozone, 79
 Bourrouillou, on method of inhaling sprays, 255
 Brand, on ammonia in coryza, 115
 Bretonneau, on chlorine in diphtheritis, 92
 on oxygen in croup, 71
 Briau, on penetration of nebulized fluids, 215
 Bromide of ammonium, 309
 of potassium, 309
 Bromine, 110, 114, 183, 309
 Bronchiectasia, 65, 149, 288, 301
 Bronchitis, 38, 46, 59, 78, 82, 87, 94, 108, 112, 113, 117, 119, 122, 123, 135, 136, 138, 141, 142, 145, 148, 149, 152, 155, 157, 160, 161, 170, 179, 180, 263, 264, 266, 269, 271, 274, 275, 277, 278, 279, 286, 295, 297, 300, 301, 306, 308, 309, 314
 Bronchorrhœa, 108, 152, 288, 290, 296, 297, 311, 315
 Brunton, on nitrite of amyl, 131

Buchardt, on carbolic acid, 155
 Bumstead, vaporizer of, 29, 175
 Burow, on nitrate of silver in powder, 338
 Burrall, on nitrite of amyl, 133
 Buttles, inhaler of, 29

Cade, oil of, 312
 Caillens, on oxygen, 62
 Calomel, 176, 337, 366
 vaporizers, 28, 29
 Camphor, 13, 14, 30, 107, 123, 151,
 164, 179, 311, 363, 368
 Camphorated tincture of opium, 157, 324, 329
 Cancerum oris, 276
 Cannabis indicum, 157, 331
 Caraway, 150
 Carbolic acid, 13, 46, 109, 115, 154,
 308, 313
 water, 313
 Carbon, oxygen in poisoning from, 69
 Carbonate of potassium, 274
 of sodium, 273, 368
 Carbonic acid, 13, 83, 114, 200, 371,
 372
 water, 268
 Carbuncles, 78
 Carburetted hydrogen, 87
 Carcinoma, 155, 298
 Carrick, inhaler of, 25
 Cases of aphonia, 96, 125
 asphyxia, 68
 asthma, 35, 306, 330, 353
 bromine poisoning, 183
 bronchitis, 123, 301
 bronchorrhœa, 108
 carbonaceous lungs, 351
 coal-miners' black lung, 354
 coryza, 105
 croup, 72, 128, 130, 168, 264,
 292, 310, 316, 318
 diphtheria, 73, 126, 127, 167,
 319, 320
 ganglionic enlargements, 65
 grinders' asthma, 353
 haemoptysis, 281, 283
 laryngitis, 285
 œdema of the larynx, 293, 325
 phthisis, 75, 76, 101, 104, 239,
 244, 271, 327, 328, 331
 pulmonary gangrene, 145, 277
 sore throat, 299
 stenosis of the larynx, 288
 tonsillitis, 325

Cases of whooping-cough, 81
 Cassia, 150
 Castor water, 334
 Catarrhs, 36, 97, 107, 116, 118, 122,
 134, 135, 136, 142, 147, 149, 153,
 155, 165, 166, 178, 245, 266, 269,
 270, 274, 275, 284, 289, 295, 297,
 298, 301, 311, 327, 330, 363, 364,
 365, 368

Cedar, 151
 Cephalgia, 65
 Chambers, apparatus of, 341
 Chamomile, 151, 179
 Champouillon, on penetration of nebulized fluids, 217
 Chapman, on pyroligneous acid, 154
 on tobacco in spasmodic croup,
 162

Chaptal, on oxygen, 62
 Charrière, inhaler of, 27
 spray producers of, 187
 Chartroulle, on iodine, 104
 Chaussier, on oxygen, 62
 Chenopodium, 179
 Cheron, on oxygenated essences, 151
 Cherry, bark of wild, 330, 333
 Cherry-laurel water, 163, 333
 Chevandier, on pitch, 137
 Chloral, 14
 Chlorate of potassium, 276, 386
 Chloride of ammonium, 13, 115, 136,
 274, 366, 368
 nascent vapors of, 32, 118
 of copper, 176
 of iron, 278, 333
 of mercury (corrosive), 304
 of sodium, 267
 of zinc, 298

Chlorinated soda, 276
 Chlorine, 13, 30, 31, 32, 91, 276
 water, 276

Chloroform, 13, 118, 131
 Chlorosis, 38, 63, 65, 77
 Cholera, 69, 70, 79, 120, 177, 265
 Cigarettes, arsenical, 171
 compound narcotic, 161
 ioduretted, 105
 mercurial, 173, 174
 of belladonna, 161
 of stramonium, 158
 and opium, 159
 and sage, 160

Cinchona, 342
 Clapham, on nitrite of amyl in seasickness, 133
 Clarke, on ether, 122
 A., nebulizer of, 199

Clemens, on chloride of copper, 176
 Cloves, 150
 Coal-miners' lung, 353, 358
 Codman and Shurtleff, steam nebulizer of, 209
 Cohen, spray producer of, 205, 210
 Cold air, 136
 Colic, 120
 Collins, on creasote water in scarlatina, 313
 on proportion of nebula inhaled in spray, 249
 Cologne water, 180, 264
 Coltsfoot, 134
 Combustion, fumes of substances volatile by, 14
 Compressed air, 37, 58
 analogy of oxygen and, 66
 and rarefied air, 37
 substitutes for, 61
 Condensed air, 37, 58
 Congestion of lungs, 38
 Coniferæ, resinous vapors of the, 136
 Conium, 98, 152, 161, 286, 309, 331
 Consumption, 34, 36, 59, 142, 271, 372
 Copaiiba, 135
 oil of, 312
 Copland, on oil of pine, 149
 Copper, chloride of, 176
 oxide of, 362
 sulphate of, 297, 337
 Corrigan, apparatus of, 31, 95
 Corrosive sublimate, 174, 183, 304
 Coryza, 83, 84, 105, 106, 114, 115,
 120, 122, 153, 155, 156, 165, 173,
 263, 274, 275, 277, 278, 296, 297,
 313, 363, 364, 365, 366, 368, 369
 Cottereau, on eblorine, 92
 Coughs, 87, 119, 154, 158, 159, 160,
 161, 162, 163, 164, 165, 166, 189,
 268, 269, 270, 290, 309, 311, 323,
 324, 329, 330, 331, 332, 333, 334
 Counting, in asthma, 36
 Cow-houses, residence in or near, 371
 Coxe, his substitute for Corrigan's apparatus, 32
 on cool air, 36
 on copaiba, 135
 Creasote, 13, 151, 312
 Crichton, on naphtha, 154
 on tar, 140
 on turpentine, 144
 Croup, 71, 72, 73, 108, 110, 114, 120,
 126, 130, 144, 162, 165, 166, 175,
 179, 180, 181, 258, 264, 269, 274,
 279, 288, 290, 291, 310, 314, 315,
 318, 321, 322, 363, 366, 367
 Croup kettles, 182
 Cube, on compressed air, 46
 Cubeb, 150, 344
 oil of, 312
 Cuirass, pneumatic, of Hauke, 54
 Cummins, on sulphurous acid, 112
 Curran, on iodine in diphtheria, 109
 Da Costa, on inhalation of oxide of copper by operatives, 362
 on lime water in diphtheria, 319
 on tannin spray in croup, 293
 Dagouillon, on ammonium, 114
 Dannecy, on saturating narcotic plants with nitre, 159
 Darwin, apparatus of, 336
 Davy, on nitrous oxide, 80
 Delore, on penetration of nebulized fluids, 217
 Demarquay, on carbonic acid, 85
 on hydrogen, 83
 on oxygen, 63
 on penetration of nebulized fluids, 225
 Dewar, on sulphurous acid, 112, 321
 Diabetes, 77, 79
 Dickson, on grinders' asthma, etc., 361
 Digitalis, 136, 332
 Dioscorides, arsenical cigars of, 171
 Diphtheria, 73, 77, 92, 96, 109, 110,
 112, 113, 126, 166, 175, 181, 258,
 264, 276, 278, 279, 288, 290, 291,
 313, 315, 319, 321, 322, 363, 366,
 367
 Disinfectants, 277, 278
 Dittel, on oil of pine, 150
 Dobell, residual-air-pump of, 44
 Domanski, on compressed air, 46
 Drake, on cold air, 36
 Ducroy, on oxygen, 67
 Duffield, on steam in poisoning by bromine, 183
 Dunton, on tar, 142
 Durand-Fardel, on penetration of nebulized fluids, 231
 Dust, diseases from, 349, 350, 359
 Dyspepsia, 63, 65, 66, 78
 Dysphagia, 324, 331
 Dysphonia, 113, 122, 268, 343
 Dyspnœa, 59, 121, 122, 142, 154, 158,
 164, 311, 332
 Earth-baths, 87, 371
 Eberle, on steam, 179

Eberle, on tar, 141
 Ebert, on nitrate of silver in powder, 338
 Eckard, on oxygen, 65
 Eclectic inhaler, 24
 Effects of the inhalation of nebulized fluids, 250
 Elliotson, on chlorine, 93
 on creasote, 152
 on iodine, 99
 Emphysema, 38, 39, 59, 77, 94, 112,
 119, 147, 269, 271, 275, 297, 306,
 308, 309, 312, 315, 321, 332, 334
 Epilepsy, 78, 131
 Epistaxis, 107
 Erichsen, on asphyxia, 68
 Ergot, 296
 Erysipelas, 80, 277
 Essential oils, 150
 Ether, 13, 121, 179
 hydriodic, 103
 Ethereal oils, 14
 Ethmuller, on opium, 156
 Eucalyptus, 151
 Experiments as to penetration of nebulized fluids, 213
 as to penetration of powders, 345
 of Auphan, 229
 of Bataille, 229
 of Beigel, 247
 of Briau, 215
 of Champouillon, 217
 of Cohen, 55, 86
 of Collins, 86, 249
 of Delore, 217
 of Demarquay, 63, 85, 225
 of Eckard, 65
 of Erichsen, 68
 of Fieber, 233
 of Fournié, 219, 346
 of Gerhardt, 244
 of Gratiolet, 229
 of Hauke, 89
 of Harwood, 17
 of Kollmann, 65
 of Lewin, 236
 of Mackenzie, 245
 of Moura-Bourouillou, 229
 of Pietra-Santa, 214
 of Rey, 218
 of Rosenthal, 347
 of Sales-Girons, 230
 of Schnitzler, 235
 of Smith, 64
 of Störk, 235
 of Tavernier, 228
 Experiments of Tobold, 235
 of Waldenburg, 244
 of Zenker, 356
 Expiration, forced, of atmospheric air, 35
 into condensed air, 58, 60
 into rarefied air, 59, 60
 Face-pieces, 28
 Fennel-seed water, 329
 Fetid breath, etc., 109, 155, 269, 276,
 277, 278, 311
 Fever, ephemeral, 112
 hay, 323
 intermittent, 66, 133, 323
 scarlet, 77, 112
 typhoid, 66, 80, 112
 Fieber, on cold water spray in haemoptysis, 262
 on penetration of nebulized fluids, 233
 on tannin spray in croup, 293
 Fleming, on inhalation of oxide of copper by operatives, 362
 Forced inhalation of atmospheric air, 33
 inspiration of atmospheric air, 61
 Fourcroy, on oxygen, 62, 63
 on the air in the vicinity of cow-houses, etc., 372
 Fournié, on penetration of nebulized fluids, 219
 on penetration of powders, 223,
 346
 spray-producer of, 192
 Fox, on ozone, 80
 Francis, on oxygen in scarlatina, 77
 Fränkel, apparatus of, for condensed and rarefied air, 52
 Frankincense, 134
 Fuchs, on chloride of ammonium, 116
 Fumes, 13, 14, 134
 Fumigator of Mandl, 26
 Gadberry, on ether in bronchitis, 123
 on ether in croup, 130
 Galbanum, 136
 Gannal, on chlorine, 91
 Gangrene of the lungs, 94, 145, 177,
 277, 278, 279, 288, 290, 295, 296,
 297, 306, 311, 314, 315, 365
 Gas, illuminating, 87, 115

Gases, 13, 14
 inhalation of various, in whooping-cough, 89

Geiger, on lime in croup, etc., 166

Geiseler, on chloride of ammonium, 116

Gerhardt, on oil of pine, 149
 on penetration of nebulized fluids, 244

Gibb, on penetration of nebulized fluids, 245

Glandular enlargements, 65, 138

Glycerin, 268, 275

Goin, on carbonic acid, 84

Gottwald, on bromine, 110

Gout, 65, 78, 79, 112

Grantham, on ammonium in whooping-cough, 115

Gratiolet, on penetration of nebulized fluids, 229

Greenhow, on grinders' and miners' asthma, 353

Grinders' asthma, 353

Gum arabic, 270, 368

Gymnastics, respiratory, 145

Hager, on aminonia in coryza, 115
 on carbolic acid in coryza, 155

Hand-ball nebulizers, 199, 202, 212

Harwood, experiments of, 17
 on ammonium, 113

Hauke, on inhalation of various gases in whooping-cough, 89
 pneumatic euirass of, 54
 portable apparatus of, for compressed air, 43

Hay-asthma, 162
 fever, 323

Hæmatemesis, 60

Hæmoptysis, 36, 38, 59, 119, 160, 250, 262, 278, 279, 280, 281, 283, 288, 290, 295, 296, 297

Hæmorrhoids, 60

Hearing, loss of, 126

Heart, affections of, 267
 nervous, 157, 171, 306
 valvular diseases of, 39, 60, 78, 274

Hepatization, 38

Hinton, on nitrite of amyl, 133

Hippocrates, apparatus of, 13, 27

Hoarseness, *see* Dysphonia.

Hodson, on chlorine in diphtheria, 96

Hoffman's anodyne, 122

Home, on carbonic acid gas, 84

Hooper, on oxygen, 67

Hops, 150

Horizontal nebulizers, 201, 203, 210

Huette, on iodine, 103

Hunter, on vapor of hot water, 179

Hydrocyanic acid, 114, 163, 333

Hydrogen, 82
 carburetted, 87
 sulphuretted, 83

Hydrokomion of Bergson, 204
 of Siegle, 208

Hydrostatic nebulizer, 200

Hyoscyamus, 162, 295, 329, 366

Hyperæsthesia, 331

Hypochondria, 63

Hysteria, 132, 136, 156

Iced water, 250, 262

Illuminating gas, 87, 115

Influenza, 61

Inhalation of airs, gases, vapors, and fumes, 13
 of dust, 350
 of nebulized fluids, 184, 246, 257
 immediate effects of, 250
 manner of conducting, 251, 303
 of powders, 223, 336

Inhalations, cold, 15, 30
 hot, 15, 17
 temperature of, 17, 253, 254

Inhalatorium of Auphan, 184
 of Sales-Girons, 185

Inhalers, of Buttles, 29
 of Carrick, 25
 of Charrière, 27
 of Corrigan, 31
 of Hooper, 67
 of Jackson, 172
 of Laugenbeck, 29
 of Langlebert, 28, 175
 of Mackenzie, 24
 of Mandl, 26
 of Merril, 30, 107
 of Mudge, 19
 of Muhlenberg, 27
 of Pomeroy, 30
 of Scudamore, 23
 of Snow, 27
 Wolfe-bottle, 21

Inhaling, method of, 15, 251, 261

Inspiration of compressed air, 58
 of rarefied air, 58, 60

Insufflators, 340, 341

Intermittent fever, 65, 133

Iodide of potassium, 306, 308

Iodine, 13, 14, 30, 96, 166, 307, 314

Iodoform, 110
 Ipecaenana, 333
 Ireland, on resinous vapors, 136
 Iron, 278
 chloride of, 278
 oxide of, 356
 sulphate of, 278, 295, 368
 Ischias, 136

Jackson, on oxygen, 67
 Jenner, on vapor of water and acetic acid in diphtheria, 181
 Jumping-rope, exercise with, 34
 Juniper, 150
 Junod, on compressed air, 37
 Jurine, on oxygen, 62
 Jütte, on oxygen in cholera, 70

Kidneys, catarrh of the pelvis of the, 150
 Kollman, on oxygen, 65

Lactic acid, 322
 Lactucarium, 157
 Laennec, on asthma, 36
 on chlorine, 93, 94
 on iodine, 97
 Lange, on compressed air, 41
 Langenbeck, inhaler of, 29
 on cool air, 36
 Langlehert, vaporizer of, 28, 175
 Laryngeal excrescences, 288, 290, 304
 Laryngismus, 119
 Laryngitis, 106, 109, 134, 138, 148, 150, 155, 157, 163, 170, 174, 179, 245, 266, 267, 268, 275, 279, 285, 286, 291, 297, 299, 308, 309, 312, 314, 315, 321, 322, 333, 337, 365, 366
 Lassègue, on chloride of ammonium, 116
 Lead, acetate of, 298, 337, 342, 368
 Lee, calomel vaporizer of, 176
 Lender, on ozone, 79
 Lente, on ether in croup, 128
 Leuthlen, on bromine, 110
 Lewin, apparatus of, 32, 118, 339
 on balsamic vapors, 135
 on chloride of ammonium, 118
 on inhalation of powders, 339, 344
 on iodine, 105
 on oils of pine, 148

Lewin on penetration of nebulized fluids, 236, 239
 spray-producers of, 190, 194, 204, 257, 258
 Liebig, on compressed air, 41
 Lime, 166, 183, 315
 water, 269, 315
 Liniment, Stokes's, 145
 turpentine, 145
 St. John Long's, 145
 Little, on chlorine, 94
 on iodine, 99
 Livingston, on ether in croup, 128
 Lobelia, 333
 Louis, on chlorine, 93
 Lue, on iodine in coryza, 105
 Ludlow, on bismuth by insufflation, 365
 on salicylic acid by insufflation, 369

Mack, compressed air-chambers of, 41
 Mackenzie, inhaler of, 24
 on carbolic acid, 155
 on oil of pine, 150
 on penetration of nebulized fluids, 245
 Mackintosh, on tar, 141
 on vapor of hot water, 179
 Mandl, inhaler of, 26
 on creasote, 152
 Mans, spray-producer of, 203
 Marjoram, 150
 Mastic, 136
 Materia medica, articles of the, suitable for inhalation in powder, 362
 in spray, 259
 Mathieu, spray-producer of, 188, 192, 238, 280
 Matthews, apparatus of, 343
 Mead, on balsamic vapors, 134
 Measles, 80
 Medicated atmospheres, 370
 Melancholia, 156
 Menorrhagia, 60
 Mercury, 14, 172, 304, 337, 366
 inhalers for, 28, 29
 Merril, inhaler of, 30
 on camphor, 166
 on iodine, 106
 Method of inhaling powders, 340
 sprays, 251, 261
 vapors and fumes, 15
 Milk, 257

Milliet, on compressed air, 38
 Millstone-makers' phthisis, 352
 Mineral waters, 184, 266, 270
 Mint, 151
 Mitchell, on nitrite of amyl, 131
 Monell, on asthma, 35
 Morphia, 157, 295, 324, 329, 367
 Morton, on chlorine, 95
 on tar, 142
 Moura-Bourouillou, on method of
 inhaling sprays, 255
 on penetration of sprays, 229
 Mouthpieces, 19, 22, 47
 Mudge, inhaler of, 19
 on tar, 140
 on vapor of hot water, 178
 Murray, on chlorine, 92
 on iodine, 98
 Musk, 123
 Myrrh, 336, 368

Naphtha, 153
 Narcosis, 67, 69, 133
 Narcotic cigarettes (Trousseau, Es-
 pic), 161
 Narcotics, 14, 122, 156, 324
 Narghilé of the Persians, 136
 Nascent chloride of ammonium, 13,
 32, 118
 Nebulized fluids, inhalation of, 184
 Nebulizers, *see* Spray-producers.
 Nephogène, of Mathieu, 188
 Nervous affections, 66, 80, 119, 156,
 157, 171, 304
 Neuralgia, 66, 78, 131, 138, 157,
 171, 306, 368
 Nevins, on mercury, 173
 on nitrous acid, 82
 on stramonium, 159
 Niemeyer, on penetration of nebu-
 lized fluids, 245
 on turpentine, 147
 Nitrate of aluminium, 304
 of potassium, 163
 of silver, 245, 298, 337, 338, 342,
 365
 Nitre, 159
 paper, 163
 Noma, 276
 Nordmann, on ether in aphonia, 125
 Number, strength, and duration of
 inhalation of sprays, 257
 Nutgalls, 336

Oakum, 142

Edema of larynx, 198, 290, 293,
 325, 363
 of lungs, 38
 Oertel, on vapor of water in diph-
 theria, 181
 Oil, almond, 269
 cod-liver, 269
 of cade, 312
 of copaiba, 312
 of cubeb, 312
 of turpentine, 311
 olive, 269
 Oils, volatile ethereal, 14
 Olive oil, 269
 Oliver, on carbolic acid, 154
 on oakum, 142
 Opium, 122, 123, 156, 179, 285, 286,
 309, 323, 327
 oxygen, in poisoning from, 69
 Snow's inhaler for, 27
 Oral inhalers, 29, 30, 378
 Oxide, nitrous, 13, 80
 Oxygen, 13, 61, 90, 200, 372, 378
 analogy between condensed air
 and, 66
 physiological effects of, 63
 Oxygenated essences, 151
 Ozanam, on bromine, 111
 Ozone, 79, 136, 138, 378
 Ozonic ether, 79

Pancoast, on chlorine in aphonia, 95
 Paper, nitre or saltpetre, 164
 makers, exemption of, from
 phthisis, 91
 Paralysis, 66, 78, 80, 112
 Paregoric, 324, 329
 Pasch, on chloride of ammonium, 117
 Pathological proofs of penetration of
 nebulized fluids, 239, 244, 283
 of powders, 350, 361
 Paul, on oxygen in narcosis, 69
 Peacock, on millstone-makers' phthi-
 sis, 352, 360
 Pearson, on ether in phthisis, 121
 on hyoscyamus in phthisis, 162
 Pellitory, 159
 Penetration of nebulized fluids, ex-
 periments on, 213
 of powders, experiments on, 345
 Peppermint, 324, 334
 Percival, on carbonic acid, 83
 Permanganate of potassium, 278
 Persians, inhalations as pursued by
 the, 135, 174
 Peru, balsam of, 134

Pharyngitis, 38, 106, 117, 174, 245, 266, 267, 274, 275, 276, 279, 290, 297, 298, 299, 308, 321, 366, 368
 Physick, on ether, 122
 Phosphoric poisoning, 148
 Phthisis, 38, 46, 60, 74, 76, 79, 80, 82, 83, 84, 87, 91, 92, 93, 94, 97, 98, 99, 100, 102, 104, 105, 110, 112, 121, 134, 138, 141, 142, 145, 147, 150, 151, 158, 161, 162, 163, 171, 264, 267, 268, 269, 271, 275, 277, 279, 280, 288, 291, 298, 299, 300, 306, 308, 311, 313, 314, 315, 321, 324, 327, 328, 331, 333, 352, 360, 371
 Physiological effects of oxygen, 64
 Pietra-Santa, on penetration of nebulized fluids, 214
 Pine forests, 136, 138, 370
 oils of, 148, 312
 mountain, 148
 Scotch, 148
 Piorry, on iodine, 100
 Pipe-inhalers, 30
 Pistachia, 136
 Pitch, 137
 Plants, exhalations from, in whooping-cough, 90
 Pleurisy, 59, 60, 178
 Pneumatic chambers, 38, 39, 40
 cuirass, 54
 Pneumonia, 38, 39, 78, 119, 122, 178, 267, 274, 323
 Pocket steam nebulizer of Beigel, 211
 Poggiale, on penetration of nebulized fluids, 230
 Poisoning by bromine, 183
 by phosphorus, 148
 Polak, on inhalations by the Persians, 135, 174
 Polyps, nasal, 364, 368
 Pomeroy, inhaler of, 30
 Porter, croup-kettle of, 182
 Potassium, arsenite of, 306
 bromide of, 309
 carbonate of, 274
 chlorate of, 276, 368
 iodide of, 306, 308
 permanganate of, 278
 Powders, inhalation of, 223, 366
 Pravaz, on compressed air, 37
 Pretty, croup-kettle of, 182
 Priestley, on oxygen, 61
 Pringle, on steam, 178
 Proportion of nebula inhaled in spray, 247
 Pserhofer, on nitrate of silver in powder, 338
 Ptyalism, 276
 Pyroligneous acid, 154
 Quinia, 136, 323
 Rachitis, 63
 Ramadge, on cool air, 36
 on forced inspirations, 34
 on turpentine, 145
 Rarefied air, 37, 40, 43, 54
 Raspail, on camphor, 165
 Rauchfuss, insufflator of, 340
 Read, steam nebulizer of, 211
 Red precipitate, 337, 366
 Residual-air-pump, 44
 Resinous plants, 14
 vapors, 136, 139, 379
 Respirators, 142, 154, 375
 Respiratory diet, 376
 Retort inhaler, 27
 Rey, on penetration of nebulized fluids, 218
 Rhatany, 296
 Rheumatism, 112, 137, 157
 Rhigini, on iodoform, 110
 Rhythmic respiration of compressed and rarefied air, 55
 Riadore, on nitrous oxide, 80
 Richardson, on oxygen in asphyxia, 67
 spray-producer of, 203
 Ringer, on iodine in coryza, 106
 and Murrel, on ipecacuanha in winter cough, etc., 334
 Rodgers, on oxygen in cholera, 69
 Rohn, on nitrate of silver in whooping-cough, 302
 Rose, on condensed and rarefied air, 49
 Rosenthal, on penetration of powders, 347
 Rush, on steam, 178
 on tar, 140
 Sage, 151, 160, 179
 Sahndall, on compressed air, 38
 Sales-Girons, apparatus of, 186
 inhalatorium of, 185
 on indications for inhalations of sprays, 260
 on penetration of nebulized fluids, 230

Sales-Girons on respiratory diet, 376
 on sprays, 184
 Salicine, 136
 Salicylic acid, 369
 Saline waters, 267
 Salt, 270, 275, 307, 368
 Salter, on chloroform in asthma, 120
 on stramonium in asthma, 158,
 160
 on tobacco in asthma, 162
 Saltpetre, 163
 Sanderson, on compressed air, 40
 Sass, horizontal nebulizer of, 201
 Scarlatina, 77, 112, 179, 278, 288,
 313
 Schnitzler, on penetration of nebu-
 lized fluids, 235
 spray-producer of, 191
 Schütz, on bromine, 110
 Scorbutus, 78
 Serofula, 63, 78, 301, 304, 308
 Seudamore, inhaler of, 23
 on chlorine, 93
 on conium, 161
 on ether, 121
 on iodine, 98
 Sea-air, 370
 artificial, 97, 270, 373
 sickness, 133
 weed, in phthisis, 97
 Semeleder, on penetration of nebu-
 lized fluids, 245
 Senile catarrh, 107
 Shumman, on nitrous oxide, 80
 Siegle, rules of, for inhaling sprays,
 253, 255, 256
 steam nebulizer of, 206
 Silver, nitrate of, 298, 337, 338, 365
 Simon, on iodine, 104
 Simpson, on carbonic acid, 87
 Sims, on stramonium, 158
 Skoda, on ether, 122
 on turpentine, 145
 on vapor of hot water, 179
 Smee, on ammonium, 113
 Smith, on oxygen, 64, 74
 Snow, on camphor, 165
 on conium, 161
 on iodine, 27
 on opium, 156
 on turpentine, 145
 Snuff, 363, 368
 Sodium, bicarbonate of, 269, 273,
 368
 carbonate of, 273, 368
 chloride of, 267. *See* Salt.
 Solon, on balsamic vapors, 134
 Solon, on stramonium, 158
 Sore throat, 263, 268, 276, 288, 290
 304, 308, 313, 325, 363, 367
 Spasm, 118, 131, 132, 136, 156, 164,
 165, 166, 189, 266, 290, 309, 324,
 330, 331, 332
 Speech, loss of, 126
 Spengler, on carbonic acid, 84
 Spray, inhalation of, 184
 producers, 186, 188, 190, 191,
 192, 194, 196, 198, 199, 200,
 201, 203, 205, 206, 209, 210,
 211, 212
 Squill, 121, 179
 Stables, residence in or near, 371
 Steam, 170, 178, 181, 183, 191, 206
 nebulizers, 212
 Stehberger, on glycerin in croup,
 269
 Stenosis, 59, 288
 Stokes, on chlorine, 94
 on conium, 161
 on iodine, 99
 on turpentine, 144
 Stony concretions in the lungs, 358
 Störk, apparatus of, for compressed
 and rarefied air, 56
 apparatus of, for insufflation of
 powders, 339
 on penetration of nebulized
 fluids, 235
 Stramonium, 158, 164, 332
 Styrax, 134
 Substitutes for compressed and rare-
 fied air, 61
 Sugar, 368
 of milk, 337
 residence in or near manufac-
 tories of, 372
 Sulphate of copper, 297, 337
 of iron, 278, 368
 of zinc, 296, 337, 369
 Sulphur, 14, 111, 367
 Sulphuretted hydrogen, 83
 Sulphuric acid, 112, 322
 Sulphurous acid, 112, 266, 321
 waters, 259, 266
 Summary on inhalation of nebulized
 fluids, 334
 Surgical affections, oxygen in, 66
 Syncope, 133
 Syphilis, 78, 138, 155, 174, 268, 304,
 305, 308, 309, 322, 337, 366
 Syringe for sprays, 188

 Tabarie, on condensed air, 37, 38

Tanneries, vapors from, 372
 Tannin, 245, 268, 270, 289, 363, 368
 Tar, 14, 30, 139, 315
 water, 288, 315, 330
 Tavernier, on penetration of nebulized fluids, 288
 Temperature, best, for inhalations, 17
 of sprays, 253, 254
 uniformity of, during inhalation, 14
 Tetanus, 131
 Thomas, on nitrate of silver in powder, 342
 on nitrous acid, 81
 Thompson, on chlorine, 93
 Thorn apple, 158
 Tobacco, 158, 160, 162
 Tobold, on penetration of nebulized fluids, 235
 Tolu, 134
 Tonsillitis, 61, 113, 142, 262, 266, 274, 276, 278, 297, 325
 Toulmouche, on chlorine, 93
 Tracheitis, 38, 268
 Tracheotomy, 183
 Traube, on penetration of dust, etc., 351
 on turpentine, 148
 Treutler, apparatus of, for compressed and rarefied air, 57
 Troussseau, and Pidoux, on balsamic vapors, 134
 contrivance of, for inhalation of powders, 337
 mercurial cigarettes of, 173
 narcotic cigarettes of, 161
 on ammonium, 114
 on arsenic, 171
 on inhalation of powders, 337
 on penetration of nebulized fluids, 228, 232
 on stramonium, 158
 on tannin spray in oedema of the larynx, 293
 Tuberculosis, 81, 109, 197, 239, 271, 301, 323, 328, 332
 Tubes, for camphor, 165
 for powders, 339
 of Bergson, for nebulization, 197
 of Winterich, for nebulization, 201
 Turpentine, 30, 46, 131, 134, 138, 144, 311
 Tweedie, on balsamic vapors, 134
 Tweedie, on steam, etc., 179
 Typhoid fever, 65, 66
 Ulcers, 78
 Vapors, 13, 14
 Vaporizers, 27, 28, 175, 176
 Varec, in phthisis, 97
 Vinegar, 141, 179, 181, 264
 Virchow, on carbonaceous lungs, 358
 Vivenot, on compressed air, 39
 Vogel, on camphor, 166
 Vogelsang, on bromine in whooping-cough, 111
 Waldenburg, apparatus of, for condensed and rarefied air, 45
 inhaler of, 27
 on ammonium in coryza, 115
 on camphor, 166
 on lime-water in diphtheria, 319
 on penetration of nebulized fluids, 244
 spray-producer of, 190
 Walford, apparatus of, 32
 Wanner, on vapor of water in croup, 181
 Water, 262
 alkaline, 267
 carbonic acid, 268
 cold, 262
 hot, 177
 iced, 250, 262
 mineral, 184, 266
 saline, 267
 sulphurous, 259, 266
 vapor of, in cholera, 70
 with spray, in cholera, 191
 warm, 262, 293, 329, 330
 Waterman, on aromatic alcoholic inhalations, 180
 Wedemann, on penetration of nebulized fluids, 245
 Whooping-cough, 38, 39, 81, 87, 89, 90, 91, 111, 112, 115, 119, 122, 131, 132, 141, 144, 147, 154, 155, 156, 157, 160, 162, 163, 268, 269, 274, 279, 287, 295, 302, 309, 323, 324, 330
 Wild, on whooping-cough, 131
 Wild cherry, 330, 333
 Winterich, horizontal nebulizer of, 201

Wittmeyer, on nebulized water in cholera, 265	Zdekauer, on pathological proofs of penetration of nebulized fluids, 244
on oxygen and vapor of water in cholera, 70	Zenker, on iron in the lungs of oper- atives, 356
Wolfe-bottle inhaler, 21	Zinc, chloride of, 298
Wood, on tar, 142	oxide of, 367, 369
Wool, undressed, 139	sulphate of, 296, 327, 369
Xanthoxylum, 179	





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